ent. Pesticides Control Service.

Insect Control Manual for Structural Pest Control Operators in Ontario

Ontario

Ministry of the Environment

PESTICIDES CONTROL SERVICE

MINISTRY OF THE ENVIRONMENT
PESTICIDES CONTROL SERVICE

INSECT CONTROL MANUAL

FOR

STRUCTURAL PEST CONTROL OPERATORS

IN ONTARIO

Toronto, Ontario
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ACKNOWLEDGMENT

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I am particularly grateful to Professor H.W. Goble, whose valuable contribution made the completion of this manual possible.

J. G. KURYS
Editor

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PREFACE

This outline has been prepared for the licensed Pest Control Operators in Ontario. Most of the materials listed are available from retailers with a "B" license under the Environmental Protection Act. Some very highly toxic chemicals are available from "A" licensed premises only.

This outline describes the common structural pests troublesome in Ontario as well as many rarely found. It will be valuable and instructive to all Pest Control Operators. If still more detail is required, obtain a textbook such as:

1. Recognition of Structural Pests and their damage by Harvey L. Sweetman, Wm. C. Brown Company Publishers, Dubuque, Iowa.
2. Handbook of Pest Control by Arnold Mallis, Mac Nair-Dorland Company, 101 West 31st Street, New York.

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CHAPTER I

GENERAL ENTOMOLOGY

INTRODUCTION

Thousands of species of insects have presently been defined. This staggering number greatly surpasses the total of all other species of animals.

Insects having lived on the earth for nearly 300 million years are far more adapted and better qualified to exist on the earth than are humans. Cockroaches and silverfish, two of the most common household pests, are little changed from their fossil ancestors present in the Carboniferous Age.

Insects greatly vary in size, ranging from 1/100 of an inch to about 10 inches in length. The wing spread of insects ranges from 1/50 of an inch to one-foot wide. Some insects are so minute that they cannot be seen by the naked eye, while some tropical beetles are as large as a man's fist.

Most insects are not harmful to man and in fact, are very beneficial. For example, some bees provide honey and pollinate plants; silkworms provide raw silk; many wasps are parasitic on other insect pests, some are predators, and some insects are used in medicine or as food. They have also provided valuable scientific information. Only a few species are harmful to man by feeding upon, destroying and damaging his food and property, or annoying and injuring man and animals through painful bites and stings. Some stored food product pests cause allergies. The immature stages of certain flies burrow into flesh or infest the digestive system causing myiasis. In addition, insects and other arthropods are the vectors of over one hundred human diseases.

Many insects may cause little or no harm, and certain people cringe at any insects that crawls. This phenomenon is termed "entomophobia" meaning fear of insects.

The term "insect hallucination" is applied where the person has an imagined infestation of arthropods or other organisms on his person, or on his skin, or on his effects. There may be a 'triggering' arthropod that might bring on this emotional aberration. The key question is to ask how long this individual has had the problem, and if he is the only one in the family experiencing this. One of the cautions the pest control operator should employ, is to urge the complainant to present an actual arthropod specimen which is capable of biting or irritating, if such is the allegation. It is recommended that the individual see a physician or dermatologist to relieve the itching or annoyance. To the individual with indications of delusions of parasitosis there is no fear of insects (entomophobia), and they are most eager to present 'specimens' for identifications.

In North America, an estimated 90,000 insect species have been described, of which approximately 10,000 species are considered to be of economic importance. This number creates a challenge to the pest control industry, public health officials, and to other related professional fields. We can expect to wage this continuous battle as long as insects and humans continue to exist together on the earth.

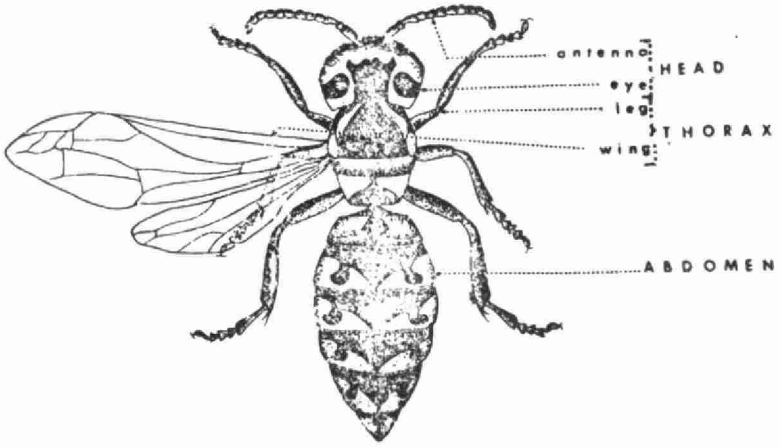
To better understand the mechanics of pest control and to offer more effective service, the pest control student should familiarize himself with a basic knowledge of entomology, especially the anatomy (structural body form) of insects, growth and development, and their food preferences. He should also be aware of the developmental stage of the insect causing the damage, and its behavioral aspects, and be capable of determining the identity of the insect, in addition to chemical control, production, sales, management and care of equipment.

EXTERNAL INSECT ANATOMY

The term 'bug' in popular language is defined in Webster's dictionary as follows: "..... an insect of almost any kind, especially a beetle, or an insect which creeps or crawls like a beetle". The term has been broadly used, and a great many of the crawling creatures have been tagged with the name "bug".

Body Form

The body of true insects is divided into three principal sections, the head, thorax, and abdomen. Among the true insects' close relatives, such as spiders, scorpions, ticks and mites, the body is composed of only one or two regions.

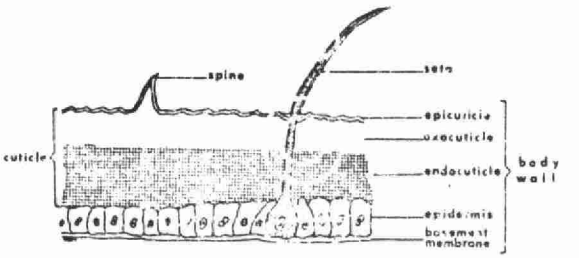


The general structure of an insect

The insect body is usually cylindrical and tube-like, with an equal number of appendages on each side, 1 pair of antennae, 3 pairs of jointed legs in the appendages, forming a definite pattern in the body region, in an expression of bilateral symmetry in which one side of the insect is a mirror image of the other.

The Body Wall

Man and other higher animals have the bony skeleton on the inside of the body (endoskeleton). Insects lack a bony skeleton but instead have a stiffened exoskeleton (outer skeleton) which protects and supports the internal organs. It is to this framework the muscles are attached. The exoskeleton, or body wall, stiffened in certain parts of the insect, flexible and quite durable, is composed of the cellular epidermis and a non-cellular complex substance called cuticle (or cuticula), containing a characteristic chemical compound called chitin. The cuticular layer, epidermis, and the basement membrane together form the body wall of the insect.



Structure of the body wall of an insect, diagrammatic.

The cuticle is composed of three layers, the epicuticle, exocuticle, and endocuticle. The epicuticle is a thin, outermost waxy layer that prevents the loss of body moisture and saves the insect from dehydration. It is a non-permeable layer, and of interest to the pest control student, as insecticides and sorptive dusts must penetrate this layer to kill the insect. The exocuticle and endocuticle are slightly thicker layers containing chitin. Below the cuticle lies another cellular layer, the epidermis, and beneath it is the non-cellular basement membrane.

Insects grow by molting (shedding the outer skin) until they have reached the adult stage. Shortly after molting, the body wall of an insect is soft and pale colored, and is sometimes referred to by laymen as an 'albino', but the cuticle gradually gets darker and hardens. The hardening of the cuticle is called sclerotization. The cuticle is sometimes covered by sensory hairs, spines, or scales.

The Head

The first of the three body regions of an insect is the capsule-like head which bears compound eyes (in most insects), ocelli (simple eyes), antennae and mouth parts.

- the compound eyes are located conspicuously, one on each side of the head. These eyes are made up of several to many individual eye elements called ommatidia (singular - ommatidium).

- The ocelli (simple eyes) are located between the compound eyes. Usually there are three, but some insects may have two, one, and less frequently, none.

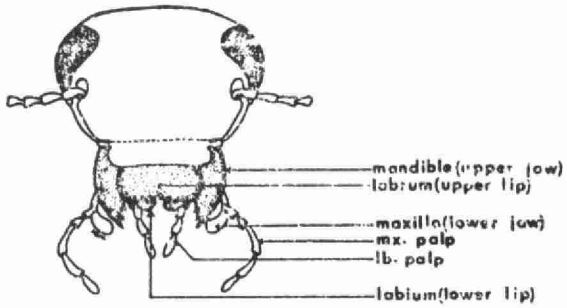
- Antennae ('feelers') are sensory in function and act as organs of smell, touch, communication, and in some cases, for hearing.

  Antennae vary greatly in size and form in different insects, but the generalized insect antenna is typified by the filamentous, or many-jointed form. Other types include setaceous, or bristle-like; filiform or thread-like; monoliform or bead-like; serrate or saw-like; pectinate or comb-like; plumose or feathery; clavate or club-like; capitate, in which the end segments are knob-like; lamellate, where the end segments are broad and plate-like; and geniculate or elbowed.

Mouth Parts

The mouth parts are used to locate and ingest food. Insect mouth parts vary more than any other organ in the insect body. Insect mouth parts can be classified into three general categories: chewing, sucking and sponging.

- Insects with chewing mouth parts are capable of grinding solid food with their mandibles (jaws). The mandibles are used for masticating (chewing) food substances, whereas the maxillae and labium are used in assisting the mandibles during feeding. The maxillary and labial palpi bear sensory hairs which are used to taste and smell food. Springtails, cockroaches, crickets, beetles, termites, and chewing lice are examples of a few insects having chewing mouth parts.

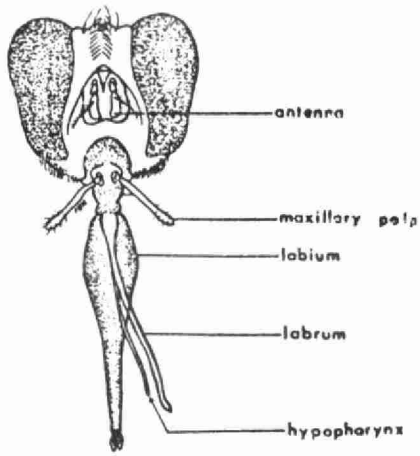


Chewing mouth parts of a cockroach, diagrammatic.

- Chewing-lapping mouth parts are a variation of the chewing type. Honey bees, bumble bees and wasps are good examples. In this case, the mandibles and labrum function as in the chewing type, but the maxillae and labium are modified into a tongue adapted for lapping up liquid food.

- All insect larvae (even though the adults may have different types of mouth parts) possess chewing mouth parts, which in some, may be greatly simplified and reduced.

- Sucking mouth parts. Piercing-sucking mouth parts are found in mosquitoes, stable flies, horse flies, deer flies, kissing bugs, fleas, and sucking lice. These mouth parts are constructed on different basic plans. They are represented by a proboscis which is a slender, tubular beak within which are enclosed 4 long slender stylets, which pierce the skin or tissue to suck up liquid food. The sucking lice do not possess a beak, and the piercing mouth parts are withdrawn into the head.



Piercing-sucking mouth parts of a stable fly, diagrammatic.

- Rasping-sucking mouth parts are found mainly on the thrips. The stylets are used to lacerate the plant tissue, and the flowing sap is sucked up by the cone-shaped mouth.

- Siphoning mouth parts, which is a specialized type, are found in moths and butterflies. The proboscis, or the sucking tube (formed by a part of the maxillae), is very long and joined in such a manner as to form a thin, hollow tube through which nectar and water are sucked up. When not in use, this proboscis is retracted under the head, like a watch spring.

- Sponging mouth parts have evolved from the chewing type. Typical examples are house flies, blow flies, and flesh flies. The tip of the labium is modified into a large sponge-like organ known as labella. These mouth parts are specialized so as to feed on exposed liquids by sponging, or by picking up food such as sugar which has been dissolved by the saliva.

Thorax

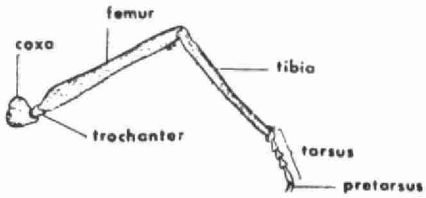
The thorax is the second of the three main regions of the insect body. The thorax is the muscular part of the insect body, and is composed of 3 segments, prothorax (foremost segment), mesothorax (middle segment), and metathorax (third segment). One pair of legs is attached to each of the thoracic segments. Wings, if present, are attached to the meso- and metathorax. The thorax is connected to the head by a flexible neck region called the cervix. The spiracles (slit-like openings into the respiratory system) are generally situated on the sides of the thorax as well as on the abdomen.

Wings

Most adult insects have two pairs of wings, but some have only one pair, and others have none. Wings are membranous outgrowths of the body wall and are supported by reinforced structures called veins. Insect wings vary greatly in size, shape, and arrangement of wing veins, and thus are important in identification.

Legs

Insects belong to the order Arthropoda, because their legs are always jointed, and are grouped in the class Hexapoda, because they have six legs. Their legs are composed of six parts. The first segment is called coxa and is attached to the body by a membrane. The trochanter is a small segment which is freely movable on the coxa. The femur attaches to the trochanter, and is usually the largest and strongest part of the leg. The tibia is the fourth part and slightly more slender than the femur. The tarsus (corresponding to the foot of man) is usually divided into 1 to 5 sub-segments. The pretarsus is the last tarsal segment and usually terminates into a simple claw-like structure.



Leg of an insect

Abdomen

The abdomen is the third or terminal region of the insect body. It usually consists of 11 segments, the last segment being represented by appendages. Spiracles are present on either side of some of the abdominal segments. External sex organs, if present, are the claspers of the male (usually on the 8th and 9th segments), and an egg laying device, the ovipositor on the female. The last segment may bear tail-like appendages known as cerci.

Sensory Organs

Insects possess the five types of senses: sight, touch, smell, taste and hearing.

Sight - insects have two types of eyes, compound eyes and simple eyes (ocelli).

Touch - the antennae, tarsi and cerci are organs of touch. Besides these, most insects possess sensory hairs on their body which are very sensitive to touch.

Smell - the organ of smell is mainly localized in the antennae.

Taste - taste perception is usually located on the mouth parts. Some flies can taste through their tarsi.

Hearing - insects do not have ears, and sound waves are perceived by sensory hairs on the body, by the antennae, tympanum, and other modifications found on the legs.

INTERNAL INSECT ANATOMY

Digestive System

Insects feed on a variety of foods and their digestive system must be capable of breaking these down into simple carbohydrates, fats, and proteins. The digestive tract extends from the mouth to the anus. It is divided into a foregut, midgut, and hindgut.

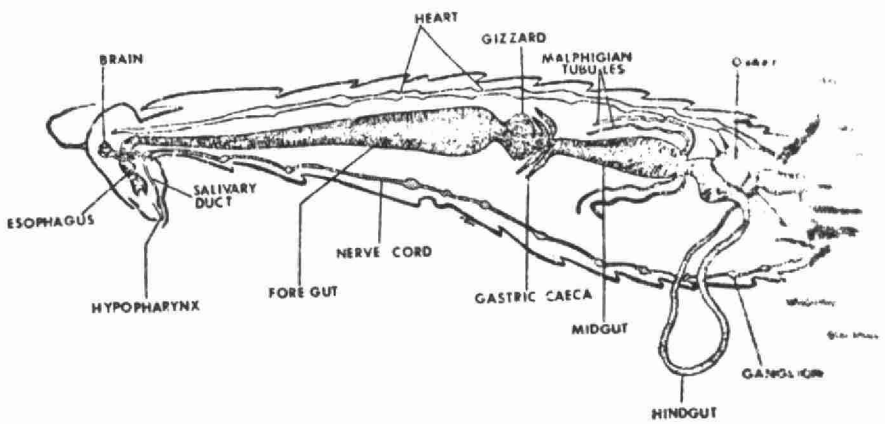
Circulatory System

The circulatory system of an insect is an open one. The blood, instead of flowing in closed veins, circulates freely within the body cavity. The only blood vessel is an open end tube situated just above the digestive tract running from the head to the end of the abdomen. The heart (the rear part of the tube) is divided into several chambers having valves. Blood flows through the heart, is pushed out the front part of the tube into the head, flows freely through the body cavity, and is then picked up by the heart again.

The blood, or haemolymph, of insects is usually a greenish-yellow fluid and performs several functions, a few examples being the transportation of waste products to the excretory organs, and the healing of wounds.

Excretory System

Excretion is the process of discharging the waste products from the body. Wastes are excreted through the body wall, the



Internal organs of a cockroach, diagrammatic

digestive tract, and the rectum. Wastes are also extracted from the blood by specific excretary tubes known as malphigian tubules, located at the junction of the mid- and hindgut.

Nervous System

The insect brain is situated in the head, and encircles the foremost portion of the digestive tract. It then extends as a ventral nerve cord below the digestive tract. The ventral nerve cord is typically double and extends to the tip of the abdomen. The nerve cord is connected in most of the body segments by a ganglion.

The sense organs of insects, such as the antennae, mouth parts, and tarsi, all have nerve endings. These sense organs are affected when subjected to contact pesticides.

Respiratory System

Insects breathe by means of a complicated system of air tubes which branch out carrying oxygen to all parts of the body and appendages. The main tubes, known as tracheae, open externally at the spiracles. The tracheae also transport waste gasses from the body tissues. Of special interest to the pest control operator are the spiracles, which can be clogged by the use of non-toxic dusts, thus preventing the intake of oxygen and killing the insect.

Muscular System

The muscular system serves to move the segments and appendages of the body. The muscles are joined to the infoldings of the exoskeleton or body wall, called phragmata. The muscles of insects are very strong, and yellowish or colorless. Some insects have approximately 4,000 muscles, whereas man has only 400 to 500. Insects can perform remarkable feats with the use of their muscles; for example, some midges can flap their wings up to 1,000 times per second, and many flies are capable of flapping their wings up to 400 times per second. Insects can also lift over 20 times their own weight.

Reproductive System

Males and females are found in most insects, and usually mate before eggs are produced. Males are generally smaller or more slender in their body form than the females. The reproductive organs are usually located at the posterior (rear) section of the abdomen. In adults, the external openings of the reproductive organs (in males, claspers and penis, and in females, ovipositor) are on the lower side towards the tip of the abdomen.

NUTRITIONAL REQUIREMENTS

Due to the large number of insect species, there is a great variation in their diet. Basically, insects require carbohydrates, fats, vitamins, proteins, and to some extent, minerals.

It is essential to be aware of the type of food preferred by the common household insects, as this will help in locating a particular insect infestation. Details of food preferences and areas of infestation of different insects will be mentioned in each respective lesson.

INSECT BEHAVIOR

Response to various situations in nature or under experimental conditions is termed behavior. Insects are not capable of reasoning. Instinctive responses may be to light, temperature, moisture, hunger, smell, chemicals, and other foreign elements,are usually either towards or away from them. House flies and certain moths, for example, are attracted to light, whereas cockroaches and bed bugs tend to avoid light.

There are many other complex behavior patterns. A few of the various examples of complex instinctive actions are, egg laying habits, killing prey, dancing of the honey bee in the hive to indicate to other worker bees the location of flowers having nectar. Most of these arise from simple stimuli mentioned above.

Insect brains are only capable of learning or improving their behavioral actions to a limited degree. It is here that man has a great advantage of gaining a thorough knowledge of the various aspects of insect life history and behavior, thus he is able to use his skill and imagination in overpowering these pests. Being aware of the behavioral aspects of certain insects will help the technician in locating their breeding places and predicting their movements, thus providing better control measures.

DEVELOPMENT, GROWTH, AND METAMORPHOSIS OF INSECTS

The development of an insect normally begins with the fertilization (fusion of the sperm and egg), and the growth of the insect ceases when it reaches the adult stage.

Most insects develop from eggs that are laid, but in some cases, aphids and flesh flies for example, the larvae (young) are born alive from the eggs that were already developed within the body of the female fly.

Eggs vary greatly in size; some cannot be seen by the naked eye, while others are about 1/8 inch in diameter. Some insects, such as certain

aphids, may lay only a single egg, whereas a termite queen may lay a million or more eggs during her lifetime.

Egg laying is also characteristic. Some lay singly, some in groups, and others in capsules. Eggs are normally laid on or near food matter so that it is easily accessible for the young when they hatch.

Growth of the immature insect begins soo after hatching. As mentioned earlier in this lesson, once the cuticle (external body wall) is hardened, the young insect is incapable of growing until it molts. In order to grow, the insect has to shed its cuticle. This process, known as molting, takes place throughout the growth period of the insect until it reaches the adult stage. The number of times an insect molts to reach the adult stage varies from once to as many as 20 times or more. The intervals between molting are termed instars. Hence, in designating the approximate age of the immatures, we could label them as 1st instar, 2nd instar, and so on.

The life span of each insect varies greatly. Some may live only a few days after reaching the adult stage, whereas termite queens of certain species live as long as 15 to 20 years or more.

Metamorphosis refers to the changes in the body form of insects that take place during their developmental stages. In the process of reaching maturity, many insects undergo remarkable changes in their body form, sometimes in their food preferences, and in their environment. For instance, adult clothes moths or carpet beetle's larvae were once caterpillar like, the bee was once a legless grub, and adult flies developed from a maggot. Metamorphosis is of four different types:

Without Metamorphosis:

Silverfish, for example, develop into adults without metamorphosis. This means that when the young of silverfish are hatched, their general body form is very similar to that of an adult, except that it is smaller in size. With each successive instar it will then grow in size (by molting) until it reaches the adult stage. Also their food preferences and general habitats are very similar.

Gradual Metamorphosis:

Cockroaches, termites, bed bugs, and earwigs are a few examples of insects that belong to this category. There are three distinct stages in their development: egg, nymph, and adult. The nymphs (young) are very similar to the adult forms, prefer the same food, and live in the same environment, but the nymphs are smaller in size. Their wings, which first appear only as "wing pads", gradually develop into wings as they pass through successive instars to reach the adult stage.

Incomplete Metamorphosis:

Dragonflies, damselflies, and mayflies undergo incomplete metamorphosis. Eggs of these insects are normally laid in water, and the naiads (immatures) are adapted to live in the water and feed on aquatic plant and animal life. The naiads scarcely resemble the adults. When the last instar is reached, their wings are fully developed and the adults then fly away and live on land.

Complete Metamorphosis:

This is the most complete form of development found among insects. Beetles, moths, butterflies, bees, wasps, ants, flies, mosquitoes, and fleas, are a few examples classified in this category. Their development is characterized by four well defined stages: egg, larva, pupa, and adult. Eggs are usually laid where food is easily available to the young when hatch.

Larvae (singular - larva)

The young that hatch from the eggs are known as larvae. Their body form varies in different insects. The larvae of several beetles are grub-like, with a well developed head, and 3 pairs of legs on the thorax. The larvae of butterflies, in addition to the 3 pairs of legs on the thorax, also have prolegs, which are fleshy outgrowths from the lower side of the abdomen. The larvae of all flies are known as maggots, and sluggish and legless.

It is important to be able to recognize the different types of larvae, as this is an actively growing stage. In several cases, the larvae are capable of causing the most damage as they possess chewing mouth parts. Larvae of moths and carpet beetles, for example, do the actual damage to wool and fabrics, while the adults may have a completely different food preference.

Pupae (singular - pupa)

After the larva has reached its last instar in the larval stage, it transforms into a 'resting' period - this is the pupal stage. Though inactive outwardly, it is during this stage that the insects actively transform their entire structure, and development of the adult body and appendages takes place. After a given period, i.e., at the end of the pupal stage, the last molt occurs and the insect emerges as an adult.

Adults

When the insect emerges as an adult, no further growth or

development takes place. Adults have all the characteristic features of the particular species they belong to and do not change further.

A knowledge of the metamorphosis of insect pests can be greatly beneficial to the pest control technician. It will enable him to determine the species of the immature insect, or of the molted skins, the type of damage it can cause, food preferences of immatures and adults, and the type of environment it requires to complete its developmental stages. The above information will enable him to locate the damage, and institute proper control measures.

CLASSIFICATION OF INSECTS AND THEIR RELATIVES

Arthropods

All living things are divided into either the plant or the animal kingdom. The animal kingdom is divided into major groups called Phyla (singular - phylum). Insects, spiders, ticks, mites, scorpions, centipedes, crabs, shrimps, lobsters, sowbugs, and many others, belong in the phylum Arthropoda - which means joint-footed. Arthropods comprise the largest group in the animal kingdom, making up about 86 percent of all known animal species.

The phylum Arthropoda is divided into smaller groups called classes. The classes are then divided into orders. The orders are further divided into families, which in turn are divided into genera (singular - genus). The genera are then divided into specific groups known as species.

It is important to determine the identity of the insect or other pest species that is causing the damage. If a correct identification is not made, then costly damage could result from application of improper control measures.

Following are the classes of arthropods one may often encounter:

Class Crustacea - sowbugs, shrimps, crabs, lobsters, crayfish

The crustaceans have:

1. Two main body regions - the head and thorax are merged into one, and the abdomen.
2. Five or more pairs of legs.
3. Two pairs of antennae.
4. They usually live in or near water and breathe by means of gills.

Class Chilopoda - centipedes

Chilopods are characterized by:

1. Long, flat, worm-like, and many segmented bodies.
2. Head not merged with thorax.
3. One pair of antennae, or none.
4. No wings.
5. 15 or more pairs of legs, each body segment with one pair.
6. Have poisonous jaws, and can inflict painful bites.

Class Diplopoda - millipedes

Millipedes have:

1. Cylindrical, worm-like, many-segmented bodies.
2. Head not merged with thorax.
3. One pair of antennae, or none.
4. No wings.
5. Many legs, each body segment has two pairs of legs.

Class Arachnida - spiders, scorpions, ticks and mites

The arachnids have:

1. Two distinct regions: the head and thorax are fused to form a single segment, the cephalothorax, and the abdomen, as in the case of spiders and scorpions. Mites and ticks have only one body region.
2. The adults have four pairs of legs.
3. They have only simple eyes.
4. Antennae and wings are lacking.
5. Members of this class are commonly mistaken for insects.

Class Insecta (Hexapoda) - all true insects

All adult insects have:

1. Three definite body regions: head, thorax, and abdomen.
2. Three pairs of legs.
3. One pair of antennae.
4. Compound eyes, and/or ocelli.
5. One or two pairs of wings, or none.

The class Insecta is grouped into 26 orders:

1. Order Protura - telsontails
2. Order Ephemeroptera - mayflies
3. Order Odonata - dragonflies, damselflies
4. Order Plecoptera - stoneflies
5. Order Embioptera - webspinners

6. Order Zoraptera - zorapterans
7. Order Thysanoptera - thrips
8. Order Neuroptera - lacewing flies, dobson flies, ant lions
9. Order Strepsiptera - twisted winged parasites
10. Order Mecoptera - scorpionflies
11. Order Trichoptera - caddisflies
12. Order Thysanura - silverfish, firebrats, bristletails

    Common species, wingless, and about $\frac{1}{2}$ inch in length. Have a long antennae, and 2 to 3 long, slender tail-like appendages at the tip of the abdomen. Have chewing mouth parts and prefer starchy materials.

13. Order Collembola - springtails

    Minute insects about $\frac{1}{4}$ inch long and wingless. Have a furcula (a forked appendage) on the underside of their abdomen by which they can spring or jump. Occur in damp soil and humus, feeding on decaying organic matter and on the sap of plants.

14. Order Orthoptera - grasshoppers, katydids, walking sticks, mantids, crickets, cockroaches.

    Common medium-to large sized, usually 4-winged insects, some are wingless. The front wings are long, narrow and somewhat leathery. Possess chewing mouth parts and have a very wide range of food preferences.

15. Order Isoptera - termites

    Social insects living in a colony and having a caste system consisting of queens, workers, soldiers, and swarmers. Workers and soldiers are wingless, whereas the swarmers have 4 long wings of equal length. Termites do not have a 'waist' as their abdomen is broadly joined to the thorax. They have chewing mouth parts and feed on wood, cast skins, and droppings of other individuals.

16. Order Dermaptera - earwigs

    Slender, elongate, and small-to-medium sized. They can be easily distinguished from other insects by the presence of forceps-like cerci at the tip of their abdomen. Front wings are very short and leathery, the hind wings fold under the front wings. Commonly found under bark, dead leaves, and other debris; also hide in cracks and crevices. Have chewing mouth parts and feed on plants and other organic matter.

17. Order Psocoptera - psocids, booklice

Minute, winged or wingless, soft-bodied insects. They possess chewing mouth parts and are found among paper, books, and also in moist places feeding on molds, fungi, cereal, dead insects, etc.

18. Order Mallophaga - chewing lice, bird lice.

Possess chewing mouth parts and feed on pieces of skin, hair or feathers of birds and also mammals. They are small flattened and wingless insects.

19. Order Anoplura - sucking lice

Flattened, wingless insects resembling the chewing lice, but the head is much narrower than the thorax. Have piercing-sucking mouth parts and feed on the blood of mammals.

20. Order Hemiptera - true bugs

Usually 4-winged insects but some species are wingless. The basal half of the front wings are leathery, while the second half are membranous. The hind wings are membranous and fold under the front wings. Have piercing-sucking mouth parts and possess a long backward projecting beak. Have a wide variety of food preferences; many feed on plant juices, others prey on insects or suck the blood of man and animals.

21. Order Homoptera - aphids, leafhoppers, scale insects, cicadas.

Winged or wingless species, wings have the same structure throughout and are held roof-like over the body. Have piercing-sucking mouth parts and all species are plant feeders.

22. Order Coleoptera - beetles, weevils

Most species in this order are of great economic importance. The front pair of wing covers (calledelytra) are usually thickened and leathery, or brittle, forming a protective sheath. The hind pair of wings are membranous and fold under the front wings. They have chewing mouth parts and have a very wide range of food preferences.

23. Order Lepidoptera - skippers, butterflies, moths

Common soft-bodied insects, adults of most species have 4 large colorful wings covered with scales. These scales

are easily rubbed off when handling the specimens. Adults have sucking mouth parts which when not in use are coiled like a watch spring. The larvae are called caterpillars, and many species are of great economic importance in their larval stage.

24. Order Diptera - flies, mosquitoes, midges, gnats, punkies, no-see-ums.

This group is represented by small-to-minute insects that have only 1 pair of wings. The hind pair of wings are reduced to small knob-like structures called 'halteres', which function as balancing organs. Mouth parts are of the piercing-sucking type, or sponging or lapping. Many representatives of this order are of great economic importance as vectors of diseases, pests to man and animals. The larvae are known as maggots or wigglers.

25. Order Siphonaptera - fleas

Small wingless insects with backward projecting spines and bristles on their body, which is considerably flattened from both sides. These parasites have piercing sucking mouth parts adapted to suck the blood of man and other animals.

26. Order Hymenoptera - ants, bees, wasps, hornets

Most species in this order can be recognized by the pedicel or narrow 'waist' (which is the 1st abdominal segment). They have 4 small, membranous wings with few veins. Mouth parts are of the chewing, or chewing-lapping type. Many species of this order are very beneficial to man as parasites or predators on other insect pests.

CHAPTER II

ANTS

INTRODUCTION

Ants are among the more prevalent and persistent of pest insects. Several species of ants occur in Ontario but only a few kinds normally are pests. Ants affect man in several ways. The presence of ants in houses is unwelcome. Some ant species bite or sting, while others invade and contaminate foods. Certain ants encourage the presence of aphids on ornamental plants. Some ants have an objectionable odor. Carpenter ants can cause serious damage to wooden structures.

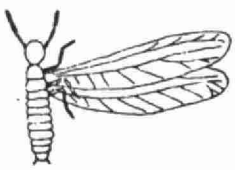
GENERAL CHARACTERISTICS OF ANTS

Ants are social insects and live in colonies composed of three distinct groups: workers, reproductive females and reproductive males.

Ants may be confused with some other insects. Termites mistakenly have been called 'white ants'. Three clear-cut characteristics differentiate the two:

ANTS

Ants	Termites
1) Elbowed antenna	1) Straight antenna
2) Front wings longer	2) Both wings equal
3) Narrow waist	3) Broad waist



TERMITES

Ants have a narrow connecting segment between the thorax and the abdomen called the petiole. This gives ants their 'wasp-waisted' appearance. The petiole in ants may be of either one or two segments. Each segment of the petiole always has a bump or 'node' on its upper (dorsal) surface. These nodes are the best structures for differentiating ants from wingless wasps, which lack this character. The colonial habit of ants also helps in recognizing them.

Ants may be divided for identification into two groups: those with one petiole segment, the '<u>single-node</u>' ants, and those with two petiole segments, the '<u>double-node</u>' ants.

SINGLE-NODE ANTS

DOUBLE-NODE ANTS

GENERAL LIFE CYCLE

Development:

Ants develop with complete metamorphosis. The life stages consist of: 1) the egg, which is very small and seldom noticed, since it is laid inside the nest; 2) the larva, which is nearly legless, nearly headless, white and helpless. It is fed by the workers, or at least food is provided; the larva changes into 3) the pupa or 'resting' stage, during which the ant re-organizes its form to that of the adult ant, either reproductive or worker; the pupa is short-cylindrical or barrel-shaped, non-active, and is the object that is seen being carried away by workers when an ants nest is disturbed; the pupa molts to disclose the 4) adult ant.

Workers and Reproductives:

The workers are wingless females with underdeveloped reproductive organs. Usually the workers are all of the same size in the same colony, and are much smaller than the reproductives, which are sometimes rather quaintly referred to as kings and queens. The reproductives are winged when they emerge but after mating and starting a colony, the wings may be lost.

The ants usually seen in pest situations are the workers. The reproductives are much less often seen.

Behaviour:

Worker ants spend most of their time constructing, enlarging or repairing the nest (which may be in the earth, in crannies of buildings or other construction, in dead wood, or in bark of trees), and in gathering food. It is the latter activity that brings them into contact with man. The helpless larvae are provided with food, often chewed up and liquefied by the workers. Food may consist of either vegetable or animal matter, and food preferences differ with the species. Some ants are attracted to sweets, others to fats, others to both fats and sweets. Ants attracted to sweets only are velvety tree ants. Thief ants usually are attracted to fats only. Carpenter, odorous house, pavement, Pharaoh's and tiny black ants are attracted to both sweets and fats. The harvester ants (red and black) eat mainly seeds.

DISCUSSION OF MAJOR PEST SPECIES

A. Velvety Tree Ant (Liometopum occidentale)

The velvety tree ant occurs throughout Ontario. It is medium-sized, with workers

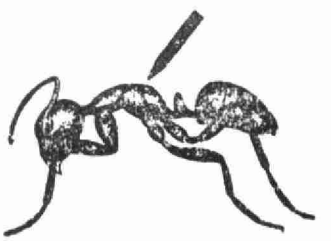
VELVETY TREE ANT

ranging from 1/8 to ¼ inch in length. It has a velvety black abdomen, a reddish thorax, and is more velvety-hairy than other pest ants. These ants form large colonies in trees, stumps, or under piles of rocks or stones.

Velvety tree ants travel in trails and may forage far from the nest. They tend honeydew producing insects such as aphids, and also kill and eat insects. If crushed, they have an odor similar to that of the odorous house ant. These ants often invade picnic or outdoor barbecue areas, invading food, biting the people and producing foul odor when killed. They seldom invade houses in search of food, but often are found in attics or other parts of the house in contact with vegetation.

Velvety tree ants are common along streams or water courses, typical places where picnics or barbecues are held. Its bite is quite painful and may persist for some time.

B. Carpenter Ant (Camponotus spp.)



CARPENTER ANT

Carpenter ants are our largest ants. The workers may be as large as 5/16 of an inch. The winged reproductives are as large as some common wasps. These ants also have smaller workers--about ¼ inch in length--in the same colony. Carpenter ants are the only ants that clear out nesting sites in wood. The burrows are open, and sawdust-like wood chips and remains of dead insects often fall in small piles below the infested wood. Ants' infesting houses are most active at night, occasionally during the day one may see them going in and out of the nest opening in the wood. Carpenter ants can do extensive structural damage to houses, rustic structures, fences and other wooden installations.

Control of Carpenter Ants

Equipment and Materials:

Inside - use small hand dusters with dust forms of the chlorinated hydrocarbons. Also a one-gallon pressurized hand sprayer may be necessary, with chlordane. Aerosols with pyrethrums, dichlorvos (DDVP) and ronnel (Korlan) are used for flushing purposes.

Outside - Chlordane should be used as emulsions in hand sprayers or in power rig sprayers; wettable powders are also used in power sprayers, or as dusts in hand, air or power dusters.

Procedures in Control of Carpenter Ants:

Inside - Carpenter ants are not always easy to control. Locating the nest is of primary importance. Look for pencil-like shavings; closely examine the window casings; look for channels by holding a hand mirror to the top or bottom of hollow doors; use a flushing agent; ask the occupant if the ants have been seen in a particular place or area.

If the nest can be located, drill small holes in the window sills, into wall voids, or above the places where indications of a nest are visible and treat these locally with chlordane dust, trying to get a general dispersal of material through the galleries. Kepone bait may also be used.

If the nest cannot be located, baseboards and door frames should be sprayed.

Outside - Even if the nest has been located inside the building and treated, in wooded areas it is important to treat the outside perimeter to prevent reinfestation.

Otherwise, spray the window sills and roof shingles. Dust or spray the under area and the outside of the foundation. Spray wood piles, trash piles and around tree stumps.

C. Odorous House Ant (Tapinoma sessile)

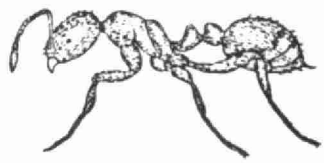
The odorous house ant is a very small, dark ant. The abdomen overhangs the petiole so that the petiole is concealed from above, and to be seen must be viewed from the side with a hand lens. The odorous house ant is found in Ontario. It travels in trails, feeds on honeydew, and invades houses readily, often persistently entrenching itself in wall voids, particularly around hot water pipes and heaters. It has a very bad odor when crushed.

ODOROUS HOUSE ANT

These ants are more prone to invade houses late in the year when honeydew is less abundant. When rainfall or leaf fall, the colonies of aphids and other insects that produced honeydew are reduced and the ants must range more widely for food, and so enter the houses.

D. Thief Ant (Solenopsis molesta)

Thief ants are some of our smallest ants, and certainly our most inconspicuous one. They are called thief ants because they may live in the colonies of larger ants, where they prey on the immatures of the larger ants.



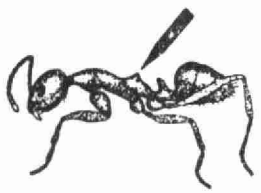
THIEF ANT

The thief ant is an important house-infesting species, but may be present without being noticed. Unobservant people, or those with failing eyesight, may complain about the flavor of food without realizing that the food is covered with thief ants. Fatty foods, such as bacon, ham and prepared meats are especially attractive to thief ants. This species usually is not attracted to sweets, starches, or fruit, but there are instances of thief ants invading sweets. Cheese is also attractive to them. They have eaten stored plant seeds, and have attacked young chickens. They also feed on dead animals and it has been suggested that they might contaminate other food in this way.

BRIEF COMMENTS ON OTHER SPECIES OF PEST ANTS

The Pyramid Ant (Dorymyrmex pyramicus)

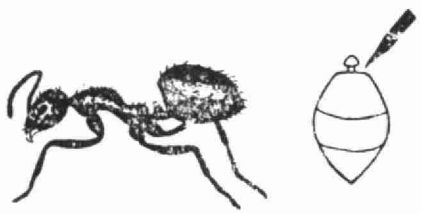
It occurs in Ontario. It is a small, dark brown ant with a hill or pyramid on the back part of the thorax. It is a house-invading species.



PYRAMID ANT

The Honey Ant (Prenolepis imparis)

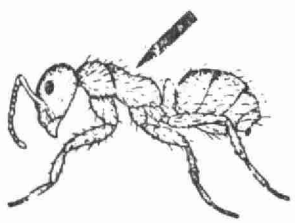
It is found throughout Ontario. It frequently invades houses. It is attracted to sweets and in dry weather may invade houses in search of water. Some individuals may store liquid food and regurgitate it when solicited by other members of the colony.



HONEY ANT

Field Ants (Formica spp.)

These are medium-sized ants that build large nests with craters in fields, yards and woodlands. They seldom invade houses but often are yard pests, tending aphids. Some capture young of other ants and raise them in their own nests, and so are called slave ants. There are several species of field ants. They are most likely to be pests of recreational areas.



FIELD ANT

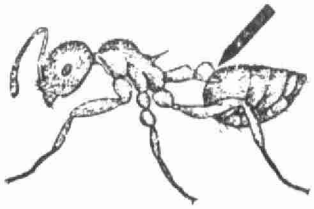
The Little Black Ant (Monomorium minimum)

It is jet black and very small. It occurs in Ontario and sometimes invades houses.

LITTLE BLACK ANT

The Acrobat Ant (Crematogaster lineolata)

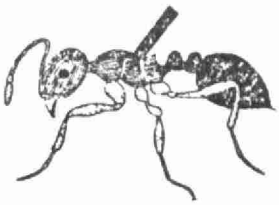
These ants when disturbed turns its abdomen up vertically, presenting a very unique appearance. These are slow-moving ants but may bite and sting, and occasionally invade houses.



ACROBAT ANT

The Pavement Ant (Tetramorium caespitum)

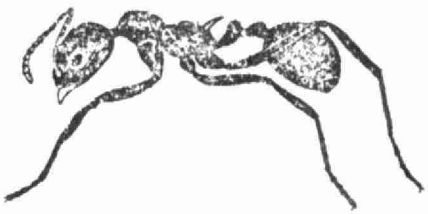
It is small, brown, with pale legs and darker abdomen. There is a pair of spines at the posterior end of the thorax. This is an important house-invading ant.



PAVEMENT ANT

The Black Harvester Ant (Veromessor spp = Messor spp.)

It makes nests similar to those of red harvester ants, but comes in contact with man less frequently. They are black in color and do not possess a beard. These ants are common on the low open hills.



BLACK HARVESTER ANT

GENERAL CHEMICAL EQUIPMENT AND MATERIALS

Inside - a one-gallon hand pressure spray tank applicator or small hand duster is usually sufficient for treating inside structures. Occasionally a power duster may be needed to treat attic areas. Insecticide sprays recommended for inside use are Baygon, chlordane, diazinon and malathion. Dusts for wall void or attic treatments can be silica gel and chlordane. Occasionally a flushing spray may be needed; aerosols with pyrethrum, dichlorvos (DDVP) and Korlan are recommended. Baits of Kepone paste or Mirex are used inside in special situations.

Outside - Chemical control outdoors requires power spray equipment for wettable powders and emulsions. Occasionally a 2- or 3-gallon pressurized hand spray is sufficient. Power dusters or hand-operated dusters are necessary for spreading dusts. Materials recommended for outside use are chlordane, diazinon and carbaryl (Sevin), used as sprays or dusts. Kepone or Mirex baits are used outdoors against harvester ants.

CONTROL PROCEDURES

1. Inside:

Ants that frequently nest indoors are: odorous house ant and the thief ant. Try to locate the nest by following ant trails to their source.

Thief Ants

Tracing these ants to their nests is frequently difficult so rather specific procedures are needed. The grouted area around sink tops should be flooded with liquid insecticides. Conduits, shelves, the under areas of sinks, cracks, and crevices must all be sprayed. If it is not possible to apply dusts through gaps under baseshoes or toe boards, these must be drilled to provide entry holes through which to force dusts. A film of spray should then be applied to the outside surfaces of the baseshoes or toe boards.

Odorous House Ants

These ants are difficult to control because the nests or points of entry frequently cannot be found. Treat behind switch plates, around conduits, television antenna lead-ins, gas pipes, or any break in the wall. In the kitchen, remove dishes, eating utensils, and foods and spray inside of cabinets, under sinks, baseshoes, and toe boards.

Treat wall and cabinet voids by drilling a small hole (1/8") into the void and inject dust with bulb or bellows hand duster.

2. Outside:

If ants are nesting outdoors, try to locate the colony by following the ants. Often the colonies are evident but those in walls, under pavement, in stone work or other places may be impossible to find. If the nests can be found, they can be treated directly. If not, other measures are required, such as power spraying of the infested area.

Velvety Tree Ants

When treating for these ants, pay particular attention to spraying crotches of trees. When trees are located near windows, velvety tree ants may infest the inside of the house.

Harvester Ants

Locate and treat the nest. Direct treatment of the nests is done by blowing dusts (chlordane, carbaryl, diazinon, etc.) into the nest opening. After dusting, spray the area surrounding the nest opening, drenching the soil well.

Odorous House Ants

Power spray the entire yard and structure sub-area for best results. Hand spraying is less effective.

CHAPTER III

BITING PESTS

BED BUGS (Cimex lectularius)

There are several species of bed bugs that are known to bite man. The human bed bug, Cimex lectularius, lives close to man and feeds upon his blood. Other species of bed bugs feed upon bats, swallows, and other birds but when these hosts are absent or reduced in numbers, then they may bite man. Since these bugs do not travel very far, the search for the sources of the bugs should start in the immediate area. Bats may be in the attic, birds in the eaves, etc.

Recognition:

The human bed bug (Cimex lectularius) is about $\frac{1}{4}$" long. It is a wingless, flat, reddish-brown insect. It has glands on its body which produce an oily liquid having a characteristic odor. An infestation of bed bugs in a room over a period of time can be recognized from the odor. After feeding, bed bugs frequently produce black specks on the seams of mattresses or walls of the bedroom where they frequently hide. A person bitten by bed bugs may continue to bleed for a short time and so there may be blood spots on the bed sheets.

Biology:

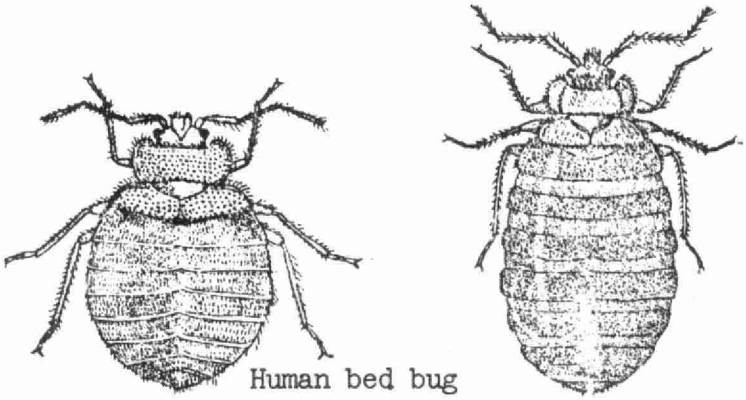
Under favorable conditions the female lays three or four eggs a day and in a lifetime she may lay about 200 eggs. The eggs are covered with a sticky material. The egg is about 1/32" in length. The eggs hatch in one to four weeks. The young bed bugs feed on the host and then molt. After about five such molts, the bed bug reaches maturity. The length of time it takes from the egg stage to maturity may be four to six weeks under favorable conditions but more than 5 months under unfavorable conditions. Adults can be expected to live from 2 to 18 months. Usually all stages may be found at any time of the year. Bed bugs can go a long time without feeding and it is believed that under certain favorable conditions they can live a year or more without food.

Where They May Be Found:

In checking an infestation, the most likely place to find bed bugs would be the seams and tufts of the mattress. From here they spread to the headboard, the rest of the bed, and then to the cracks and crevices of the walls. One should also check under loose wallpaper, behind picture frames, or furniture in the room. Bed bugs are generally found close to the people or host upon which they feed. They may also occur in theaters, infesting chairs or other convenient hiding places. Bed bugs can be carried from place to place in infested clothing or furniture.

Bed Bug Bite:

People vary in their reaction to the bite of bed bugs, some showing no reaction while others seem to suffer rather severely. Because of its habit of feeding on human blood, bed bugs have long been suspected as possible carriers of disease. Experimental evidence indicates little probability of this.



Human bed bug

Control:

Insecticides must be applied to all the hiding places to achieve good control of bed bugs. Mattresses should be sprayed lightly and allowed to dry for several hours before replacing the sheets and occupying the bed. Extra sheets might be used as a precaution.

In many places spray is still effective and may be used for control. A 0.5% lindane spray may be used on walls and other hiding places but only 0.1% lindane applied lightly on the mattresses.

Insecticide resistance to lindane may be found in some areas in which case 1% malathion spray can be used. A combination of at least 0.2% pyrethrins and 1% piperonyl butoxide may be used when babies and small children are involved, but it is advisable to treat the place again in two to five weeks. 0.5% diazinon and 0.5% dichlorvos (DDVP) are also used by pest control operators.

A pin stream nozzle is used for cracks and crevices and a fan or cone nozzle for mattresses. Treat each tuft in the mattress and the folds at the edges, as well as the bottom and sides. Spray hollow frames, spring coils, headboards, under loose wallpaper, cracks around nearby doors, windows, and moldings. Treatment of entire rooms by fogging, misting or vaporizing with diazinon and dichlorvos has been recommended.

Outside treatment is seldom necessary, but bird nests and bat harborages should be kept in mind as sources of bed bugs in unusual cases. The same insecticides used for the control of C. lectularius should be effective for these bed bugs, also.

YELLOWJACKETS, WASPS, AND HONEY BEES

Honey bees, yellowjackets, Polistes, mud-daubers and other wasps are generally beneficial to man, but they may also be a nuisance

and sometimes a serious health hazard due to their stings. In general, one could expect fewer bees and wasps in a highly urbanized area as compared to rural areas.

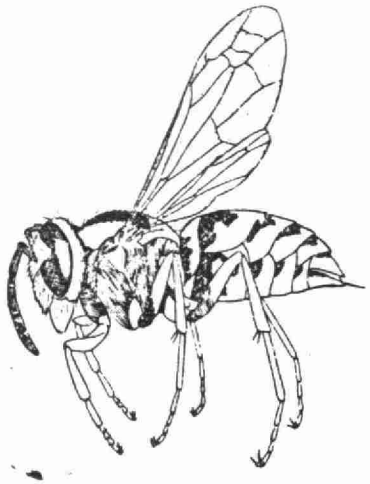
Honey Bee Stings:

The sting (or stinger) is barbed.

Usually the sting and venom sac are torn out of the body of the bee as it flies away. In these cases the sting with the sac attached remains embedded in the flesh.

Taking hold of the venom sac with the finger squeezes the sac and forces more venom into the flesh. Scrape off the sting with a fingernail or a straight edge in such a way that pressure on the sac does not force venom through the sting.

Yellowjackets and Other Wasps Stings:



The sting is smooth.

Not left in the flesh.

Two types of reactions to the venom of honey bees, yellowjackets, Polistes, mud-daubers and other wasps:

a. Toxic reaction:

1. Local swelling and pain (but massive stings could cause death).
2. Usual treatment is the application of ice to site of sting.

b. Allergic reaction:

1. According to a pamphlet by the Allergy Foundation of America, the following reaction might be expected by a person sensitive to the sting of a wasp, yellowjacket, or bee: "A highly allergic person can sustain one sting which can produce shock and prove fatal within minutes. Fortunately, these extreme reactions are rare. In moderately sensitive individuals, reactions may appear in the form of widespread swellings or hives, wheezing, faintness, dizziness, vomiting, abdominal cramps or diarrhea. There may be some shortness of breath, nasal discharge, or stuffiness in the nose and some tightness in the throat. Occasionally, there may be aching and swelling

of the joints, and a bruised appearance of the skin at a site distant from the sting. In mild reactions, all that may develop is a large local swelling at the sting area which may last several days and itch quite intensively for a time".

2. From the same pamphlet the following suggestions for emergency treatment is quoted: "The emergency treatment for a generalized reaction following an insect sting is the immediate injection of adrenalin. The spread of venom can be lessened by placing a tourniquet above the site of the sting or by the local application of ice. In the absence of any serious medical indications, known insect-sting sensitive patients should receive from their physician, prescriptions for a kit containing either an adrenalin spray or inhalation or adrenalin by injection and instructions for their use. Adrenalin is the only drug which is effective in preventing shock. Cortisone tablets and antihistamine tablets are considered useful but do not act quickly enough in the acute emergency. After emergency treatment the person should go to the nearest doctor or hospital for further treatment and observation".

Avoiding Stings - especially important to those who are hypersensitive.

a. Seasonal or climatic factors:

   1. Bees and wasps are more numerous and active during the late spring, summer and early fall months.

   2. Less likely to be active during the hours of darkness and on cold days.

b. Attractants around the premises or person:

   1. Food and cooking odors, open refuse containers, outdoor barbecues.

   2. Flowers.

   3. Water sources, such as fish ponds, etc.

   4. Brightly colored clothing should be avoided. Clothing of light color or white is believed to be less attractive to bees and wasps.

   5. Application of after shave lotion, perfume, suntan lotion and perfumed material should be avoided.

Yellowjackets:

a. Found in most parts of Ontario.
b. Nests in ground; usually abandoned burrows of small animals (mice, squirrels, etc.) in field or on slopes of hills.

Polistes spp.

a. Widespread in Ontario.
b. Nests in branches of trees, hollow trees, under loose bark, underground burrows, eaves of houses.
c. Similar to yellowjackets except they are larger and distinguishable in part by the fact that the abdomen is tapered where it joins the thorax.

Mud-daubers

a. Sceliphron spp., Chalybion spp.

    1. Widespread in Ontario
    2. Nest on eaves of houses, trees, rocks.
    3. Recognized by the long, narrow "waist" (the anterior portion of the abdomen is long and slender).

General Biology:

a. Yellowjackets and Hornets

In the fall the queen wasp and males mate (yellowjacket and hornet). The males die shortly thereafter and the queens overwinter in the ground, under bark of trees, or sometimes in buildings. In the spring, the queen emerges from her hiding place and selects a nest site. She collects materials from rotten or weathered wood, plant fiber and other material which, mixed with saliva, is used to make a kind of paper. This paper is used to build the nest. She lays eggs which hatch into larvae. She then collects food-insects and meats-which she feeds to them. They later pupate and eventually emerge as adult workers. The queen now spends full time laying eggs while the workers take over the duties of building and maintaining the nest and collecting food. As the colony increases in size, the nest is enlarged and, of course, in ground nesting species (Vespula pensylvanica and V. vulgaris)the hole in the ground is correspondingly enlarged by the yellowjacket's carrying out little balls of earth. V. maculata and V. arenaria build their nests in trees or shrubs. Sometimes V. arenaria build their nests on the eaves of houses. During the later part of the season, males and females are produced in addition to workers. As the end of the season approaches, the workers die off, the queen wasp mates and seeks an overwintering site, and the males die. The nest

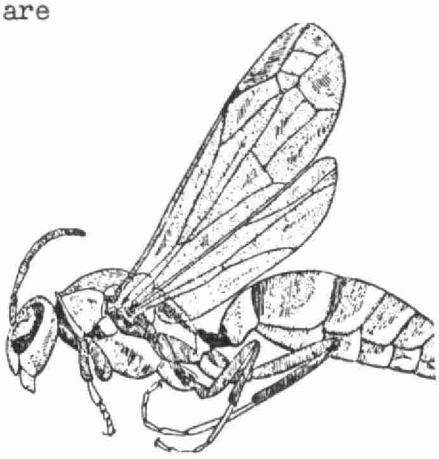
deteriorates and is usually not used again.

These insects are especially noticeable in recreational areas such as public parks, school grounds, picnic areas, around suburban homes and in certain areas where ripe fruit is present, such as an orchard or winery. They may also be present around garbage dumps, soft drink stands, and places where food is available.

Though the list of food material that ground-nesting yellowjackets may feed on is quite long, it is of two general categories: liquids high in sugar, and meats, including insects. A list of representative food includes the following: watermelon, grapes, peaches, honey, chicken, liver, horse meat, tuna, and insects. It is probable that they may feed on almost any kind of meat and many kinds of insects.

b. Polistes spp.

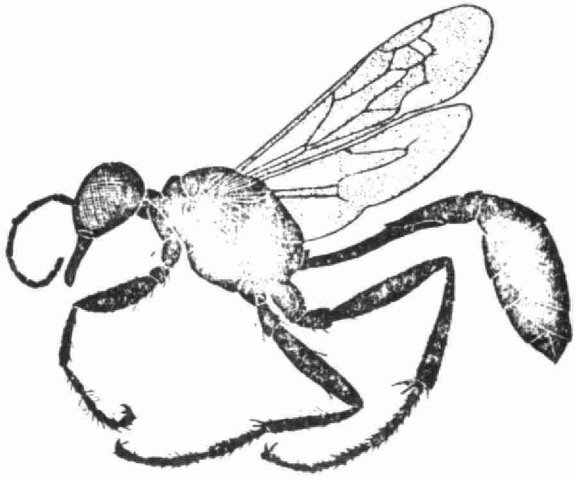
The life history of Polistes is similar to that of the yellowjacket but there are significant differences. They may be quite numerous at times but nowhere near the maximum reached by the yellowjackets. One may expect, at most, several hundred Polistes in a nest.



They build a nest consisting of a single comb (without the outer covering that yellowjackets build). They feed on insects, especially caterpillars and on juices of fruits and honey dew. At times, they may congregate in large numbers on plants where a quantity of honey dew produced by other insects is present. The Polistes queens may overwinter in the attic or basement of a home.

c. Mud-daubers

The female mud-dauber builds a nest of clay and provisions it with immature spiders which have been paralyzed by her sting. She then lays an egg in the nest and caps it. This process is repeated until a series of such nests are built side by side. There may be up to



20 nests in a cluster. She flies away and does not return.

The eggs eventually hatch, the larva feeds on the spiders, then pupates; a male or female adult emerges in about two weeks after pupation. Only males and females are produced (no workers). There may be several generations in a season.

Control:

a. Precautions

1. Use of protective clothing. Truman and Butts recommend the following: "The operator should wear high shoes which cover the ankles and a pair of heavy coveralls. The legs of the coveralls should be tied snugly over the shoe tops just below the ankles. Veiled headwear and heavy gloves are available from any supplier of beekeeping equipment. These should be used by the operator, and special care should be taken to insure that the lower end of the veil is tied securely so that the wasps are not able to slip underneath and sting the operator about the face and neck. These articles of clothing may seem rather cumbersome and unnecessary to many operators, but should one unfortunate circumstance arise when they are being worn their value will become apparent immediately".

2. Control should preferably be done at night when the insects are in the nest.

3. Persons who are allergic to Hymenoptera stings should not undertake control.

b. Control Methods

The control of ground-nesting yellowjackets, V. pensylvanica and V. vulgaris, may be considered under three general headings: a nest that is clearly located and accessible, infestation in a small area and infestation in a large area. The distinction among these three situations cannot always clearly be made; neither can the recommendations be limited exclusively to one situation.

1. Control of an accessible ground nest

a) Mark position of nest opening with a stick during the day.

At night, introduce a toxicant into the opening of the nest. Duster or spray equipment may be used as appropriate.

Avoid the use of light but if it should be necessary, use a flashlight or other forms of illumination. It

should be positioned away from a person but with the beam directed toward the opening in the ground. The yellowjackets that may fly out have a tendency to go toward the light source.

A shovel full of soil should be thrown over the opening.

b) There are pressurized aerosol insecticide dispensers developed to project a stream 6 to 12 ft. distance. A dispenser that can project a stream downwards to spray a nest on the ground may be used. Most dispensers, however, are designed to be used upwards.

2. When the nests are not located and the nuisance is due to the presence of the foraging yellowjackets, temporary relief may be obtained by trapping and destroying them. A weekly spray of 0.75% DDVP applied to the inner surfaces of trash containers, especially near the rim after the containers have been emptied in order to assure adequate application of the insecticide.

Trash containers should be conveniently located and provided in sufficient number to avoid or minimize littering which would undermine the control effort by establishing competing attractants (food for yellowjackets).

Steam cleaning of trash containers once a month is beneficial.

HONEY BEES (Apis mellifera)

Honey bees are kept not only by commercial beekeepers but by amateurs as well. For this reason, hives may be found not only in the major agricultural areas and where there are important nectar and pollen plants but in more urbanized areas, also. Local ordinances may prohibit the keeping of bees in certain areas or regulate it.

Some complaints of honey bees result from hives being kept in urban areas. The neighbours are either in fear of being stung or have been stung.

Nuisance or Public Health Aspect:

1. Nuisance (fear of being stung, swarms nest in wall of house.
2. Stings resulting in local reaction or, more rarely, serious illness or death or hypersensitive (or allergic) persons.
3. Specking of laundry, automobiles, etc., by bees in flight.

Recognition:

1. Widespread in Ontario, mainly in the southwestern part of the Province.
2. Usually in hives but may be in hollow trees or between walls in a house.
3. The honey bee is about $\frac{1}{2}$ inch long, robust build, brown color, with brown hair over body. They are active around flowers and other sources of sweets.

Biology and Behaviour:

The honey bee is one of the most intensively studied insects and the literature on it is voluminous. Only a few especially pertinent remarks on the biology and behaviour as they pertain to pest control and public health will be given here.

At certain times of the year (about March to June) the honey bee colony may divide with a portion of it leaving the original hive (as a swarm) to start a new home. The older queen with many of the older worker bees will often rest temporarily in a large cluster on the branch of a tree or on a bush. The flight of bees in and around the swarm disturbs people and there is the possibility of stings. In a short time (up to several days) they leave for a more permanent home. This may be in a hollow tree and sometimes between the walls of a building. There they set up housekeeping and build combs for storing honey and rearing new members.

During unfavorable weather the bees stay inside the hives. As soon as the weather improves, they fly out to gather nectar. Since they do not defecate in the hive, they accumulate quite a store of body waste over several days which they can dispose of during their flights. Clothes hung up to dry, parked cars, and other objects in these flight paths are likely to be specked. If these specks were examined under high magnification, pollen grains can be seen.

The subject of bee stings has been treated earlier. An additional comment on behaviour may be warranted. In order to sting, the honey bee obtains a firm hold with its claws. An experienced beekeeper will brush the bee off quickly as soon as he feels this and by doing so frequently avoids being stung.

Control:

1) Swarm of bees on a tree or bush

   a. Do not disturb until they leave, which will occur within a few hours or a few days.

   b. Call an experienced beekeeper to remove the swarm.

2) Colony of honey bees between the walls of a house (control by insecticide).

   a. Check the location of the colony. This can be done by listening.

   b. If the colony is near the entry, insecticidal dust may be introduced and the entry closed. Carbaryl (Sevin) or chlordane dusts have been recommended.

   c. If the colony is remote from the entry, a 1/8" hole should be drilled into the wall close to the colony, the entry closed, insecticide introduced into the drilled hole and the hole sealed.

   d. An established colony would have accumulated considerable amount of honey and it would be necessary to remove it. If the colony is destroyed, and a large amount of honey left in the wall, the honey would eventually seep into the wall and stain it. The honey will also be attractive to honey bees and other insects. This usually necessitates the temporary removal of part of the wall (siding, shingle) to gain access.

   e. After removing the combs of honey, the area should be liberally treated with a residual dust to discourage insect pests attracted to the old site.

   f. After treatment, the honey bees that happened to be outside when the treatment was made will attempt to find other ways to go back to the colony. This could be a temporary nuisance and the client should be informed in advance in order to avoid a call back.

3) Colony of honey bees between the walls of a house (removal by beekeeper).

   a. If the colony is established between the walls of a building, an experienced beekeeper can remove the bees by either trapping them, rehiving the bees, and allowing the bees to carry the honey from within the walls to the new hive (this will take several weeks).

4) Honey bees in the chimney.

   a. Close the fireplace damper.

   b. It is sometimes wise before applying the insecticide to seal the face of the fireplace with heavy paper and masking tape. The room should be vacated, the doors closed, and the windows opened.

   c. Blow chlordane dust into the chimney from above.

   d. Seal chimney with paper and masking tape for a day or two, if necessary.

   e. Screen chimney to prevent re-entry of honey bees.

   f. Cyanogas may be used instead of a residual insecticide, but its use should be restricted to individuals who are experienced and careful. If cyanogas is used, the entire premises should be vacated and care should be taken that the dust is not blown back into the user's face.

5) Honey bees in the attic.

   a. Dust chlordane directly to the colony. It may be possible to reach the colony through the crawl vent.

6) If the bees cause a nuisance by defecation, this could be taken care of by moving the hives. If it is an illegally kept hive, the recourse is through the enforcement of the local ordinance. At any rate, the nuisance is usually transitory and not serious.

CHAPTER IV

COCKROACHES

INTRODUCTION

Cockroaches are an ancient group of insects. Million years ago, they looked much like they do today. Most species of cockroaches are tropical or sub-tropical, living outdoors under dead leaves, moss and refuse, and on flowers and bushes.

A few species have adapted to living with man, in homes and other protected places where food, a moist environment, and warmth is available. These species are called house infesting cockroaches. They make up less than one percent of all the known forms. They are usually nocturnal and like to eat starchy materials, sweet substances, and meat products. They also feed upon many other things, such as beer, cheese, leather, wallpaper, and dead animals.

Cockroaches were brought to North America by ships from Europe and Asia. They have been spread throughout North America by means of moving merchandise and other goods.

PUBLIC HEALTH AND ECONOMIC IMPORTANCE

Damage - Cockroaches are scavengers capable of spreading filth, and contaminating far more food than they are able to eat. They damage book bindings (starchy paste), parchments, wallpaper, and stain walls and other surfaces.

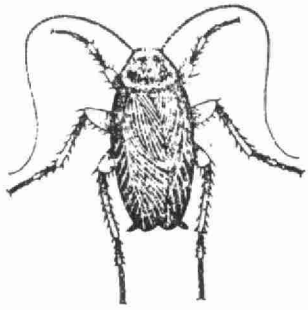
Disease - Cockroaches are not incriminated as biological carriers of disease. They mechanically contaminate foods and utensils by transporting filth on their legs and bodies which could spread organisms causing food poisoning, dysentery, diarrhea, and other illnesses.

BIOLOGY AND CHARACTERISTICS

General Characteristics

Cockroaches are oval and flat-bodied. This permits them to squeeze into very small cracks and crevices and makes it difficult to seal them off from harborages.

A pronotum (a shield-like covering) projects forward over the head.



Cockroach

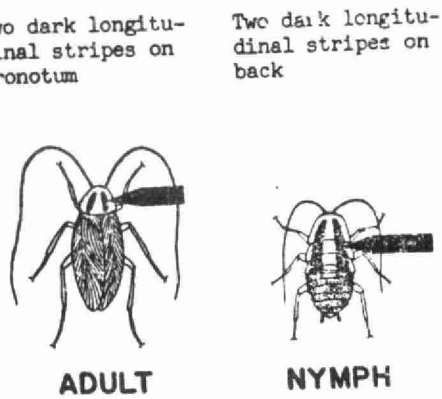
Cockroaches develop by gradual metamorphosis. The young (nymphs) resemble the adult except they are wingless.

Nymphs undergo a series of molts, growing larger each time, and with the last molt emerge as winged, fully developed adults.

German Cockroach (Blattella germanica)

Recognition:

This is the most common species found in homes and restaurants in Ontario. Adults are pale brown, about ½ to 3/4 inch long with wings covering the entire length of the body. Look for 2 dark longitudinal stripes on the pronotum. Nymphs resemble the adults except that they are wingless, darker in color and have 2 dark longitudinal stripes on the back.



Life Cycle:

The adult female carries the ootheca (egg capsule) protruding from her abdomen until the eggs are ready to hatch.

1) The ootheca is slender, about 1/3 inch long and light brown in color.
2) Capsules removed from the females more than a day or two before time to hatch do not develop.
3) The female will produce 4 to 9 capsules in her lifetime each containing 30 to 48 eggs which hatch in about 28 days at room temperature.

The completion of the nymphal stage at room temperature requires from 40 to 125 days.

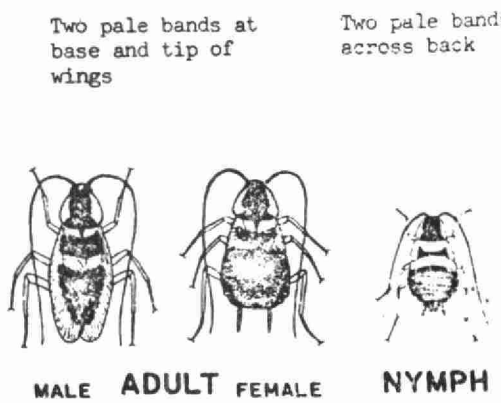
Adults may live for 200 to 300 days.

Brown-Banded Cockroach (Supella supellectilium)

Recognition:

This species is slightly smaller than the German cockroach; rarely more than ½ inch long. Adults are light brown in color. The wings have two light yellowish "V" shaped bands, one at the base of the thorax and the other at the tip of the wings.

1) The male is long and narrow with wings covering the abdomen.



2) The female is broad and flat with short wings that never cover the abdomen.

Nymphs have 2 light tan colored bands running crosswise on the body.

Life Cycle:

The female carries the egg capsule for a day or two after formation and then glues it to a protected surface.

1) The egg capsule is $\frac{1}{4}$ inch or less in length with no more than 9 eggs on each side.
2) The female produces about 14 capsules during her adult life containing at most 18 eggs with an average of 13 which hatch in 50 to 75 days depending on temperature.

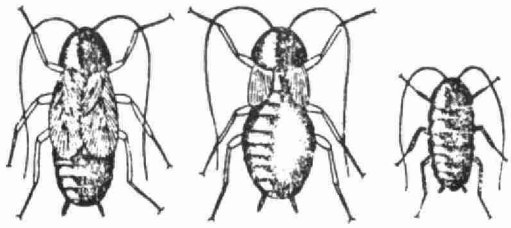
Completion of the nymphal stages varies from 90 to 270 days. Adults may live as long as 150 to 210 days.

Oriental Cockroach (Blatta orientalis)

Recognition:

This species is often referred to as the 'waterbug', or 'black beetle'.

1) The female is about $1\frac{1}{4}$ inches and the male about one inch in length.
2) The female has small wings, while the wings of the male cover about 3/4 of the abdomen. Neither the male nor the female fly.



ORIENTAL

The adults are very dark brown or black in color.

Life Cycle:

The female carries the egg capsule for about 30 hours after which it is dropped or attached to a protected surface near a food supply.

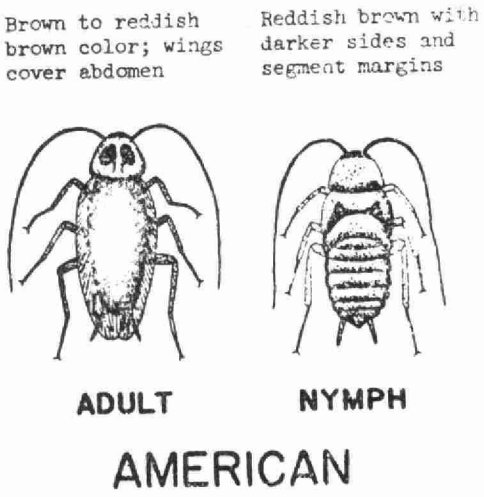
1) The egg capsule is fat, purse-shaped, and dark brown to black in color, about 1/3 inch in length.
2) The female will produce around 8 capsules, each containing 16 eggs which hatch in about 60 days.

The completion of the nymphal stages usually requires about one year.
The entire life cycle may require from one to two years, depending upon temperature and environment.
Adults may live for periods of 4 to 5 months.

American Cockroach (Periplaneta americana)

Recognition:

The American cockroach is also referred to as the 'waterbug'.
This is the largest house-infesting species in North America, measuring 1 to 2 inches long. They are uniformly reddish-brown in color and the pronotum has a pale yellowish band around its margin. The adult male and female are fully winged. The male is more adapted to flight than the female which seems to 'glide' more than actually fly.



Life Cycle:

The adult female may drop the egg capsule within a day after it is formed or it may be glued to some protected surface.

1) Egg capsules are formed at the rate of about one per week until 15 to 90 have been produced.
2) Each capsule contains from 14 to 16 eggs which hatch in 50 to 55 days at optimum temperatures.

Nymphal stages vary from 285 to 600 days with an average of over 450. The adult may live for an average of 440 days.

Wood Roach (Parcoblatta spp.)

The long-winged males of the wood cockroach, 2 2/3 to 1 inch long, may fly for long distances, and are sometimes abundant in houses; and the short-winged females also invade dwellings near woods. The life cycle is about 1 year. The egg capsules contain a maximum of 32 eggs.

COCKROACH CONTROL

Recognition of Cockroach Infestations:

Cockroaches are active mainly at night or in the dark and adults and young are normally not seen except when the infestation is severe. Determine a cockroach infestation by the following signs:

- Live or dead cockroaches may be seen. Dead cockroaches may indicate a past infestation.
- Look for fecal droppings, which may be almost as large as a mouse dropping or as small as a 'pepper'.
- Full or empty ootheca (egg capsules).
- Cast skins which the young cockroaches shed (molt) as they develp through the nymphal stages.
- Staining of walls and areas where they congregate.
- Cockroaches leave an odor on objects they rest upon, causing a musty smell. Each species of cockroach is found in a different place.

German cockroaches, although fully winged, rarely fly and are carried from place to place in items such as bagged potatoes and onions, bottle cases, cartons, and food packages.

They infest areas that are warm, moist and near a source of water and food. Small cracks, crevices and dark confined areas are preferred. German cockroaches are found behind baseboards and pictures, under or behind sinks, dishwashers and water heating equipment, tables, loose linoleum and wallpaper, in fuse boxes, under or behind stored goods and shelves, in and around motor compartments of refrigerators and dispensing machines, electric typewriters and clocks, under food processing equipment, in cash registers, in vegetable bins, around meat counters and blocks, checkout stands in markets, behind or under steam tables, stoves, toilets, furniture, and television sets.

Brown-banded cockroaches are very active and the males fly readily when disturbed. They prefer warmer and drier areas than the German cockroaches.

The female may hide the egg capsule in furniture which could account for its widespread presence in hotels, apartment houses, hospitals, and homes.

This cockroach is difficult to control, as it is found throughout a building, beneath tables and chairs, dressers and chests, behind pictures, along picture moldings, shelves in closets, on rough plaster, walls and ceilings, and especially on the ceilings and upper walls of cabinets, pantries, and closets.

American cockroaches prefer warm and moist areas. They are common in food handling establishments and industrial plants, and are the common cockroaches on ships. They live under tree bark and in hollow trees, in palm trees, alleyways, yards, basements, and are often abundant in sewer systems.

Sanitation and Exclusion:

Cockroaches require adequate food, water and shelter to survive. Making food and moisture inaccessible to these insects through good sanitation and attempting to exclude them by good building design and structural repairs are important steps in control.

Sanitation

- Garbage and rubbish should be kept in containers with tight-fitting lids and emptied frequently.

- Leaking pipes, standing water, and areas where undue amounts of moisture exist should be eliminated.

- Incoming merchandise, such as bags of potatoes and onions, should be inspected to prevent the introduction of cockroaches into an establishments.

- Empty soda pop and beer bottles should be properly stored or disposed of. Needless accumulations of boxes, stacked newspapers and other clutter should be eliminated.

- Use heavy duty industrial vacuum cleaners and portable steam cleaners in food processing plants and institutional kitchens to clean away food particles and grease.

Exclusion

- Food processing equipment in restaurants and food plants should be correctly installed and maintained.

    1. Equipment should be sealed to the wall and positioned above the floor.
    2. Hollow, open-end legs on equipment should be sealed to prevent harborage.

- Cabinets should be tightly fitted to the wall or caulked if necessary.

- Other structural features such as wall voids, cracks, open areas around pipes, dead spaces behind or beneath cabinets, wall flashings, baseboards panels, etc., should be repaired and sealed.

Chemical Control:

Equipment and Materials

- Cockroach control equipment consists of hand pressure spray tanks, foggers, misters, hand dusters, air and power dusters, flashlight and rags. Outside control requires hand and power sprayers, granule spreaders, air and power dusters.

- Materials recommended for cockroach control consist of sprays and/or dusts of diazinon, baygon, Korlan, dichlorvos (DDVP), pyrethrum with piperonyl butoxide, etc. Baits of kepone, Baygon and dichlorvos are also used. Be careful of stains with Baygon.

- Outdoors: in addition to the materials above, malathion and diazinon are recommended. In some cases, cockroaches are resistant to insecticides at the strength permissible for indoor use, but may be killed with stronger solutions outdoors.

- Much cockroach control is done in food processing plants and restaurants, etc. A careful record must be kept (especially concerning baits that are left on the premises) so that anyone will know exactly what was done and where.

Residential Cockroach Control Procedures

Before starting treatment certain preparations should be made:

- Ask the customer to leave the premises for a 4-hour period.

- Remove all pets for a 24-hour period.

- In the kitchen area, have the customer remove all dishes, utensils, and foodstuffs so the cupboards are completely bare.

- See that medicine cabinets have been emptied and that towels, sheets, etc., have been taken out of linen closets.

- Remove dresser drawers.

- Cabinets and drawers should be emptied of all items.

Thoroughly treat the following areas:

- In the kitchen treat behind the stove, in cracks and crevices in floor, wall cabinets, under the sink, under tile, around all drawers, moldings and refrigerator motors. Spray around door bells and ironing boards and holders. Appliances should be inspected and treated if necessary, with special care to see that no insecticide is applied to areas that will come into contact with food. Top moldings and mop boards and hot water heater enclosures must be treated. Always use caution when working near pilot lights. Turn them off if necessary, give sprays time to dissipate and turn them on again before you leave. Sometimes it is necessary to drill toe boards and baseboards with a $\frac{1}{4}$" drill and blow dust into that area.

- In the bathroom, under the sink and around tap.

- In the bedroom treat moldings around baseshoe, bed frame, shelves, clothes closets and dressers.

- If American cockroaches are present, spray in the 'cooler' or pantry, taking care not to contaminate food. Treat service porches, washing machines and dryers, etc.

- Outside the house where Oriental cockroaches are present, the yard should be power sprayed, covering all trash piles. Garages should be thoroughly treated with particular attention to the mud sill area.

- In the past few years the cockroach (Blattella vaga) has appeared in yards. These should be treated in the same manner as the Oriental cockroach.

Commercial Premises:

- The clean-out treatment, which is the first treatment of an unusually heavy infestation, requires more preparation and care than is needed in subsequent applications. Care should be taken at all times not to contaminate foods, food preparation areas and eating and drinking utensils.

Bars

- Bar sinks, and similar equipment in restaurants should be covered with plastic sheets carried by the pest control operator for this purpose. Never use bar towels.

- Glasses, utensils, paper goods and all things that might become contaminated from the spray should be removed and the bar sprayed thoroughly covering all cracks and crevices.

- Complete spraying or dusting around motors, ice-making machines, refrigerators, etc., should be done.

- Any place that generates heat and moisture should be treated.

- Front of bar should be sprayed around stools and rails, if necessary.

- Dust under booth seats.

- Restroom storage rooms.

CHAPTER V

FABRIC PESTS

INTRODUCTION

Many insects are capable of damaging fabric by chewing or shredding rather than feeding. Attention is given to nine species known to feed upon wool and other substances containing a tough fibrous protein called "keratin".

Keratin is the chief constituent of such things as the hair of humans and other mammals, horns, hoofs and feathers. Fabric pests are among the very few insects capable of digesting keratin. It is important to note that the larval stages do all the damage to fabrics. Adult fabric pests have different food preferences.

Fabric insects also have need for vitamins and amino acids. "Clean" wool lacks these supplements, and will support a normal insect population only after it is contaminated with soilage, food spillage, or related nutrients. Contamination is inevitable. It is caused by perspiration, body oils, and air-borne micro-organisms that produce traces of essential nutrients. Fabric is "clean" only when sterilized. Once it is exposed to superficial handling, or even air, it becomes sufficiently contaminated to provide an acceptable diet for fabric insects.

INSECT DETECTION IN FABRICS

Knowledge and experience are required of the pest control operator to aid him in locating a source of fabric insect infestation. Clothes moths and larvae are usually easier to find than carpet beetles, for they are less capable of moving much beyond their immediate supply of food. Carpet beetles, on the other hand, will move from room to room in search of new food once their principal source is consumed. When any source of infestation is found, and eliminated, preventive measures should be taken to insure against further attack.

Helpful questions the pest control operator should ask of the homeowner in detecting fabric pests are:

1) Are there any pets in the house? (Pet foods and accumulated loose hairs)

2) Are there any mounted animal specimens (trophies), forgotten collection of insects, study skins, or even fur-covered toys?

3) Are there any stored woolens, carpeting, clothing, feathers, furs, or similar material?

4) Where are such items stored—in attic, basement, back of closets or drawers, in attached garage, or elsewhere?

5) Are there any birds' nests under eaves, wasps' nests in attics or rafters of garage?

6) Is there any possibility of neglected foods, such as old spices, cereals, seeds, or something a child or pet may have hidden?

7) Is there a special storage place for seed and fertilizer, such as fish food, blood meal, or combinations of bone, hoof and horn?

These questions would serve a dual purpose: first, time required for unnecessary searching is eliminated, and second, the nature of the questions quickly informs the client that the pest control operator knows his profession.

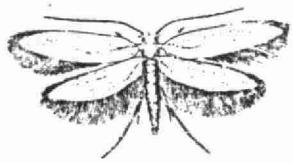
DESCRIPTION AND BIOLOGY OF FABRIC INSECTS

Nine species of fabric insects are covered in this lesson comprising of two families: moths (Lepidoptera) and beetles (Coleoptera).

Webbing Clothes Moth (Tineola bisselliella)

Recognition:

Adult - Approximately 3/8 inch in length, wings uniformly golden buff colored, top of head covered with bristling, reddish-brown hairs. Moths are light shy and weak fliers.



Webbing Clothes Moth

Larva (matured) - Approximately ½ inch long, naked and cream colored. The larvae spin webs freely over feeding purposes. Webbing is characterized by copious amounts of fecal pellets and fiber particles scattered throughout. Pellets are usually the same color as dye stuff used in fabric. Food consists of hair (wool), feathers, and other protein-containing substances.

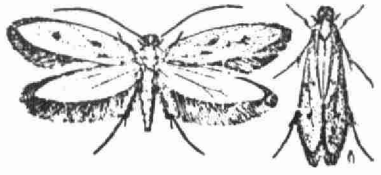
Life Cycle:

Females normally lay 40 to 50 eggs; a few may lay over 200 eggs. The life cycle may take from one month to 4 years, depending upon dietary and environmental circumstances. A normal cycle is completed in 65 to 90 days.

Case-Making Clothes Moth (Tinea pellionella)

Recognition:

Adult - Slightly smaller than the webbing clothes moth, with brown colored rather than tan colored wings. Three dark spots may be detected on each forewing of newly emerged adults; these rub off with age.



Case-making clothes moth

Larva - Unlike the webbing clothes moth larva, which is a free-webbing species, the case-maker covers its body with a silken tube. Once covered, the entire larval period is spent within, and the case dragged behind as new feeding areas are sought. Often the case is composed of dyed fiber interwoven with silk, creating a multicolored effect. The case is vital to the larva, which will die if removed from it.

Life Cycle:

Similar to webbing clothes moth. Food consists of various substances other than hair and feathers, including spices, tobacco, hemp, and some nut meats.

Remarks:

The case-making clothes moth is not as common as the webbing clothes moth, but is capable of seriously damaging hair and feathers.

Carpet Moth (Trichophaga tapetzella)

Recognition:

Carpet moth

Adult - Larger than both previous species, length 1/3 to $\frac{1}{2}$ inch. Basal third of forewings black, remainder of wings a mottled shade of white, black and gray.

Larva - Like the webbing clothes moth larva, this species also makes silken tubes throughout the material fed upon. Damage is caused by both feeding and severing of fibers, which are used in construction of tubes.

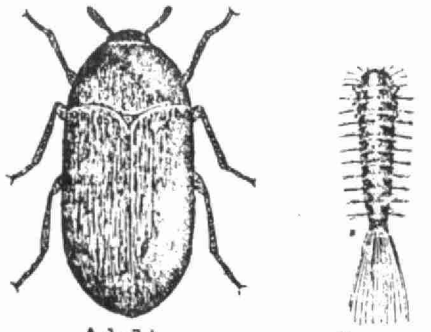
Life Cycle:

Females lay 60 to 100 eggs. Larvae persist throughout summer, undergoing 4 to 6 molts. Usually there are more than two generations a year.

Black Carpet Beetle (Attagenus megatoma (=piceus)

Recognition:

Adult - An oval, dark brown to black beetle about 1/16 inch long. Adults may be found outside feeding on pollen and enter homes during spring and early summer.



Adult Larva
Black Carpet beetle

Larva - Typically carrot-shaped, about $\frac{1}{4}$ inch long, somewhat shiny brown to black, and having long tail bristles, resembling a fine paint brush. Larvae exist under a wide environmental range, but grow more rapidly at temperatures of 80°F and relative humidity of 65%. Food consists of many protein-containing substances, including dead animal matter, hair, fur, horn, and cereals, as well as processed wool. Dead cluster flies, have been observed to serve as food for this species.

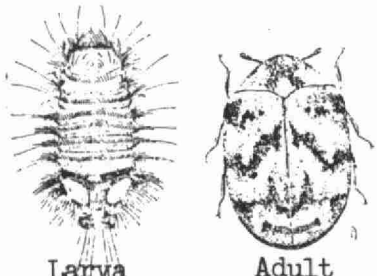
Life Cycle:

Females lay 42 to 114 eggs and generally die shortly after. Larvae may require upward of 639 days for development, if food and environment are not suitable and may undergo as many as 20 molts before reaching pupation. Under favorable circumstances pupation is reached in 258 days, and the life cycle is completed in little less than a year.

Varied Carpet Beetle (Anthrenus verbasci)

Recognition:

Adult - About 1/8 inch long, slightly oval-shaped and mottled with white, brownish, and yellowish scales. Folded wings terminate in a rounded manner with no rear cleft.



Larva Adult
Varied carpet beetle

Larva (matured) - Larva slightly wedge-shaped with rear broader than head, about 3/16 to ¼ inch long. The body appears to have a series of light and dark brown transverse stripes. Three dense tufts of bristles occur on either side of the rear, lying flat when undisturbed. When the larva is molested, these tufts extend outward in a fan-shaped display of conspicuous puffs. Food consists of woolens, skins, stuffed animals, feathers, horn, hair, silk, fish meal, cereals, and almost any processed plant or animal food. Infestations always show numerous cast larval skins and fecal pellets throughout feeding areas.

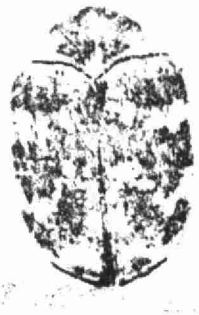
Life Cycle:

Food supply, temperature and humidity determine the length of life cycle. It varies from slightly less than 1 year to as long as 1½ years. There are 5 to 16 larval stages, with an average of 7 or 8.

Furniture Carpet Beetle (Anthrenus flavipes)

Recognition:

Adult - Slightly larger and more rounded than the varied carpet beetle, with a definite cleft at the rear. Coloring is mottled yellow, white and black, and is more conspicuous than in the varied carpet beetle.



Furniture carpet beetle

Larva - Generally torpedo-shaped with the head region wider than rear. Unlike the varied carpet beetle larva, this species is darker in color and capable of running swiftly from place to place. This species is extremely destructive to carpeting, upholstered furniture, clothing and natural fiber brushes. It feeds to some extent on cottons, linens, and synthetics if they are contaminated.

Life Cycle:

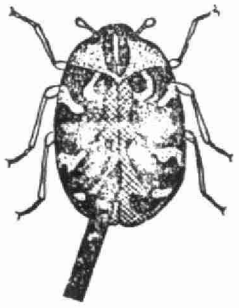
The female lays upward of 26 eggs in separate batches. Under favorable conditions, development may be completed in 10 to 13 weeks. Time from egg to adult at room temperature varies from 149 to 422 days, depending upon nature and availability of food supply.

Carpet Beetle (Anthrenus acrophulariae)

Recognition:

Adult - About 1/8 inch long, oval-shaped and blackish in color, with a varied pattern of white and orange scales appearing on back. A scalloped band of orange-red scales appears down the middle of the back. Adults feed on pollen.

Larva - Reddish-brown when matured, with numerous black or brown hairs extending outward over entire body, active in movement, running rather than crawling. They feed on woolens, feathers, leather, furs, brushes, silk, mounted museum specimens, as well as pressed plant specimens.



Carpet beetle

Life Cycle:

Average period of development from egg to adult at room temperature is 94.5 days, ranging between 89 and 108 days.

Odd Beetle (Thylodrias contractus)

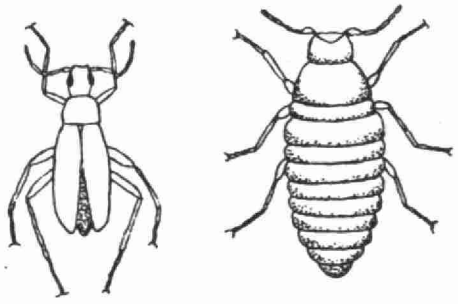
Recognition:

Adult - A yellowish-brown beetle, about 1/8 inch in length, thinly covered with pale hairs. The male and female are entirely different in appearance. The male is elongate, with long slender legs and antennae, possessing wing covers with no wings beneath. The female is larviform and without wings or wing covers.

Larva - Stout, brownish, and somewhat resembling larva of common carpet beetle, but smaller and with tail hair tufts absent. Food consists of most dry animal matter.

Life Cycle:

May require one year.



Male Female

Odd beetle

Large Cabinet Beetle (Trogoderma inclusum)

Recognition:

Adult - 1/16 to 3/16 inch long, oval-shaped, blackish in color.

Larva - Generally cigar-shaped with long bristly hairs standing out on all sides of upper body. Larvae feed on grain, seed collections, dead insects, dried casings, and similar stored substances.

Large cabinet beetle

Life Cycle:

Females lay upward of 45 eggs. Larval life of five months. Average life cycle, from egg to adult, approximately six months.

Remarks:

This species has been reared on wool but prefers other forms of animal and plant matter.

PREVENTION

Woolens, etc., should be tightly wrapped with such repellents as paradichlorobenzene or naphthalene (moth balls) to prevent fabric insect attack. Caution should be taken to sandwich these volatile substances between sheets of paper to avoid staining the fabrics. For more permanent protection, insecticides having residual life should be used. Those having low mammalian toxicity should always be selected, for many articles of clothing contact the skin. Liquid formulations of methoxychlor and perthane are in the medium toxic range, and while not as spectacular as more poisonous compounds, remain effective with a greater margin of safety.

CONTROL OF EXISTING INFESTATIONS

Many of the insecticides mentioned above might have poor contact value, especially against larvae of the black carpet beetle. Difficulty arises due to deep-seated infestations occurring within depths of carpeting or beneath or behind other infested materials. Water emulsion or even oil base sprays too often fail to reach hidden insects and woolens repel small droplets of spray. Spray equipment must impart a sufficient velocity to the insecticide droplets to force them beneath

the surface of fibrous materials such as carpeting. The "furry" nature of varied and furniture carpet beetle larvae, plus natural resistance of the black carpet beetle, tend to protect these insects against most aqueous sprays. The use of wetting agents in both oil and water sprays greatly improves penetration. For quick "knockdown", pyrethrins or allethrin should be added in accordance with label recommendations.

Carpeting should never be "soaked" with an oil spray. Penetration should be deep enough to reach the base pile but not enough to wet the synthetic or rubberized backing, otherwise "warping" may occur. A means of assuring rapid penetration and evaporation of oil spray without damage to the carpet backing is to cut base oil one-half with isopropyl alcohol (rubbing alcohol). For the first few moments following treatment with this combination, flash point is lower and odor higher; however, both undesirables dissipate quickly in a well-ventilated room. Insecticidal deposit is thus evenly distributed throughout all fiber, reaching the seat of infestation. Rapid evaporation also enables quick resumption of traffic over treated carpeting without tracking dirt on and oil off. It is not necessary to treat an entire wall-to-wall carpet that is walked upon and vacuumed regularly. Concentrate treatment on edges adjacent to walls. Attention should be given to areas under stationary furniture, or around heat registers.

PRECAUTIONARY MEASURES

- It is of utmost importance that highly toxic insecticides never be applied to any fabric within the home. Bare feet, any other exposed skin area, or the mouths of children, in contact with any treated material, could result in pesticide poisoning.
- Treated carpeting should always be dry before being walked upon.
- Droppings or excessive oil spray should always be quickly wiped away, particularly on asphalt tile.
- Spray tanks should never be set directly on floors, floor coverings, or other clean surfaces.
- Water emulsion sprays should not contact non-washable wallpaper or other materials that will color-run or stain.
- Do not spray oil solutions near open flames, sparks or electrical circuits.
- Where a mixture of deodorized spray base and isopropyl alcohol is used, particularly around floor or wall furnaces, the pilot lights must be extinguished as this mixture has a high evaporation rate with a low flash point.
- All screened windows and doors should be open during use of highly volatile sprays.

CHAPTER VI

FLEAS

RECOGNITION

Fleas are small, wingless, brown to brownish-black insects with piercing and sucking mouthparts designed for taking blood from warm-blooded animals. Their bodies are laterally compressed or flattened to allow them to move rapidly through hair or feathers. Their legs are designed for jumping. The body, legs and even the head are equipped with stout spines and hairs for gripping the host.

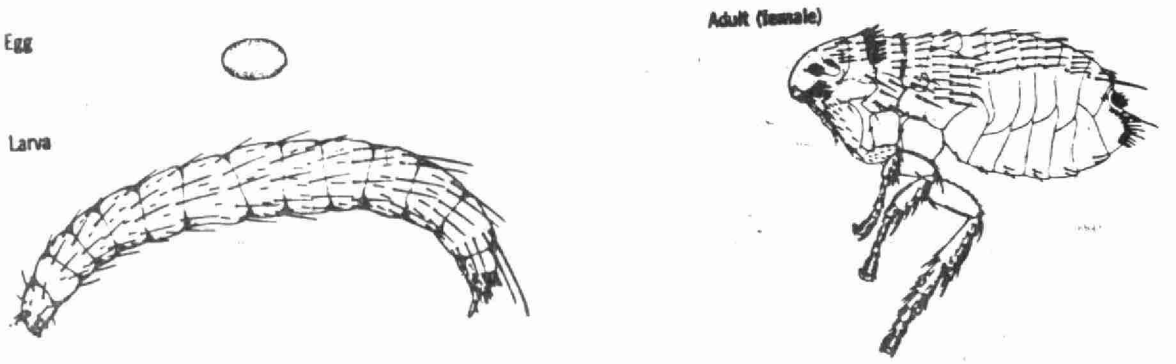
KINDS OF FLEAS

In Ontario there are about 30 species of fleas, most of which are parasites of warm-blooded animals. Only two, the cat flea, Ctenocephalides felis, and the dog flea, Ctenocephalides canis, are likely to be pests in and around the home. The European hen flea, Ceratophyllus gallinae, is sometimes a pest in poultry houses. The human flea, Pulvex irritans, is rarely a concern in Ontario.

The human flea (Pulex irritans) is a severe pest in many areas and may live exclusively on people or on a variety of domestic or wild animals. A closely related species, Pulex simulans, which cannot be distinguished from the human flea except by flea experts, also may bite people. Either species may be found on medium-sized to large animals such as goats, deer, skunks, coyotes, badgers, etc. Tracing infestations of either of these species is sometimes difficult.

Rat fleas, particularly the oriental rat flea (Xenopsylla cheopis) will infest houses and buildings that harbor rats.

A variety of wild rodent fleas will infest premises when their hosts have access to grounds, houses, or outbuildings. In Ontario these include the ground squirrel flea (Diamanus montanus), the wood rat (pack rat) flea (Orchopeas sexdentatus), and the chipmunk flea (Monopsyllus spp.).



Cat Flea

FLEA LIFE CYCLE

Fleas pass through four stages——egg, larva, pupa, and adult.

Eggs are usually laid on the animal or in its sleeping place and soon hatch into larvae. The eggs are not attached to the host and may fall onto rugs and furniture. Depending on the temperature and humidity, eggs hatch in 2 days to several weeks.

Larvae are small, somewhat hairy worm-like creatures 1/8 to ¼ inch long, that move with a rapid hitching motion, using the mouthparts for grasping and two fleshy appendages at the tail to push forward. They feed on organic debris. When disturbed, they may 'flip' in circles to escape. They are fully grown in about two weeks, then spin cocoons covered with grains of sand and debris and change into pupae.

Pupae change into adults in a week or so and adults emerge, ready to take a blood meal and to reproduce. Adults can live several weeks to more than a month without food. They must have blood in order to produce eggs.

CAT FLEAS

The cat or dog fleas are responsible for more complaints than are any other fleas. Often, their presence is obvious the moment the operator steps into an infested yard, house, or animal quarters and fleas hop from ground or floor onto trouser legs. Cat and dog fleas tend to bite as soon as they hop onto a person. Their bites are usually concentrated about the ankles or legs. The pest control operator may avoid infestation and bites by carrying an aerosol bomb (pyrethrum or DDVP) and spraying his pant legs and shoes before entering an infested area. When pets are available, flea infestations often go unnoticed. If the pet dies, or is taken away during vacations, hungry fleas emerge and become noticeable.

These fleas readily bite people, but need a dog, cat or other animal to maintain the infestation. They tend to be concentrated in the bedding or sleeping places of a pet cat or dog, but sometimes whole yards or neighborhoods may be infested, especially where the pet population is high. The sleeping quarters of pets should always be checked for fleas, larvae, and eggs. A concentration of larvae and eggs in pet quarters looks like salt and pepper because of the grayish larvae and white eggs.

Sometimes cat flea infestations are found where there are no pets. A check often reveals that a stray cat has had kittens under the house or in the basement or that pets have been removed, leaving fleas to develop and to seek hosts. Cats deliberately leave infested yards to obtain relief and spread fleas to homes without pets.

Cat and dog flea infestations are usually found with little trouble. If not found, the complaint may be due to a different flea. If a few fleas are found, but no infestation can be located, the fleas may have come from other premises visited by the person bitten or by his pet.

HUMAN FLEAS

As a general rule, infestations of the human flea are harder to find than cat and dog fleas. They do not need other animals, but can survive and reproduce on human blood alone. Larvae live on organic materials found in cracks and crevices in floors. In mild climates they live in yards. Since the widespread use of vacuum cleaners and good tile, linoleum or hardwood floors, the human flea has become less important. Occasional large infestations are found, especially where standards of sanitation are low. Usually an infestation is small, but often it is persistent.

Human flea bites tend to be concentrated about the waist or upper trunk. These fleas are voracious feeders and one flea will bite many times. The fleas feed so rapidly and so much that they eliminate undigested blood (upon which larvae may feed). Blood spots on bed linen and underclothing offer a good clue to their presence, if not caused by bed bugs.

Fleas hide in bedding and in upholstered furniture. These places must be treated when the human flea is suspected. Theater seats are notorious hiding places for fleas in areas where fleas are numerous.

A closely related flea, Pulex simulans, is known to occur on wild and domestic animals. Many reports of the human flea on such animals may be due to the presence of its near relative which could not be distinguished until recently. Either species may be introduced on game animals brought onto the premises. Both will bite people, but Pulex simulans is not known to infest houses.

RAT FLEAS

The presence of rats on premises is enough indication that rat fleas are present. Rat fleas are closely associated with their hosts. The eggs are laid in the rat's nest where hatching and development take place, but if rats are controlled, fleas leave the rat and the nest in search of a blood meal. Larvae in the nest continue to develop and become hungry adult fleas.

The oriental rat flea readily bites people when rats are not available. The tropical rat mite (Ornithonyssus bacoti) will also leave the nest and bite people. For this reason, it is important that mite and flea control measures should be done before and during rat control. In general, ectoparasite control should be considered a preliminary part of rodent control.

WILD RODENT FLEAS

Wild rodent may dig burrows in yards (ground squirrels) or construct nests in attics, between walls, or under buildings (chipmunks, tree squirrels, and pack rats). It is particularly important to control fleas on these animals because of the danger of bubonic plague.

These fleas, like the rat flea, are closely associated with their hosts. They also will bite people, but are far more likely to do so if their hosts are killed by the pest control operator or die of disease or natural causes. Ground squirrel fleas usually remain in burrows or on their hosts; the others usually remain in hosts or in nests.

CONTROL OF FLEAS

Control measures against fleas depend upon: 1) the location of the infestation, and 2) the kinds of animals involved (if any). Control measures consist of: 1) changing the environment to eliminate fleas or their animal hosts, and 2) chemical control of fleas.

Yard and outbuilding infestations may be controlled by sprays of diazinon, ronnel (Korlan), or lindane and malathion applied as water emulsion. Reduction of a large pet population or exclusion of neighborhood pets is a good suggestion. Special attention should be given to dog houses, kennel runs, barns, hog pens, chicken houses, under houses and porches—any area accessible to pets. A power spray rig is the most efficient means of getting the most material to the greatest area.

In household infestations of cat and dog fleas, animal quarters should be cleaned up and vacuumed. Sprays of DDVP in fine spray and deodorized spray base, ronnel (Korlan) or methoxychlor may be used. Oil solutions of diazinon with malathion, although odor must be considered indoors, can be used as well. Upholstered furniture should be treated with a fine non-staining oil base spray. Treat mouldings, baseboards, bed frames, floor areas and rugs. Spray thoroughly, but lightly. Do not allow pools of liquids to form, do not walk on treated areas, and avoid open flames. When oil solutions contact asphalt tiles, wipe them up immediately.

Basements and areas under houses are havens for dogs and cats. Diazinon dust will kill fleas and drive animals out. Opening should be closed to keep them out. Malathion dust gives good coverage if odor is not a problem.

Severe infestations of human fleas indoors is usually the result of poor sanitation, since larvae feed upon organic debris. Accumulations of debris and dirt in cracks, crevices and furniture should be vacuumed or otherwise cleaned out to remove harborage and food.

Fleas on burrowing rodents, particularly ground squirrels in yards, are easily controlled by application of chlordane or malathion dust placed in burrow entrances. Dust should be applied liberally by a duster. In most instances, rodent control should follow flea control.

Fleas on chipmunks, tree squirrels and rats that gain access to homes and summer cabins are best controlled by use of insecticides bait boxes followed by rodent control and rodent proofing of the structure. Silica aerogels are useful in attics.

Where access is possible to between-wall areas and in attics, the infested area may be dusted directly, followed by host control and exclusion. Infestations of cat fleas caused by invasion of an opossum are best dealt with by this method. Following treatment, access to such areas should be closed by animal proofing.

CHAPTER VII

FLIES

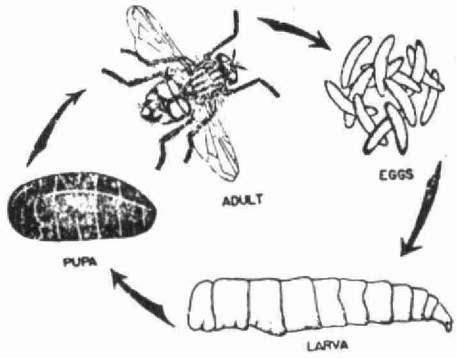
INTRODUCTION

There are more than 16,000 species of flies in North America. This lesson is concerned with 9 kinds (about 20 species) of flies that are important. Flies are characterized as follows:

1. The immature stages occur in moist, solid, organic matter and are commonly found in the solid organic wastes associated with man's activities.

2. The adults are frequently a nuisance in and around homes.

LIFE CYCLE OF DOMESTIC FLIES



Life cycle of flies

- The adult female lays small (about 1/25 inch long), white eggs in or on moist organic matter in which the larvae live. The eggs are quite susceptible to drying and usually hatch in less than one day.

- The larvae are usually white, legless maggots that avoid drying by living in moist, decaying organic matter. Most species grow until they are about $\frac{1}{2}$ inch long. They crawl down to attempt to get into soil to pupate. They crawl up the sides and out of garbage cans to get to the soil.

- The pupa is recognized by the hard, brown pupal case in which the larva transforms into an adult fly. The empty pupal case is left behind when the adult fly emerges and is a good indication of where adult flies have already emerged.

- The newly-emerged adult is sometimes called a 'crawler' because it cannot fly until its wings have expanded. After a fly emerges as an adult, it does not increase in size. Little flies do not grow into big flies.

USUAL LIFE CYCLE OF SELECTED SPECIES OF FLIES

Species	No. eggs per female	Length of Life Cycle in Days			
		Egg	Larva	Pupa	Egg to Adult
House fly	600-2400	0.3-2	3-21	3-21	7-45
Little House Fly	200-600	1.5-2	8-10	8-12	18-24
Green Blow Fly	2000-3000	0.3-1	4-8	4-10	9-18
Stable Fly	300-400	1-5	8-21	4-14	13-40
False Stable Fly	140-200	Less than 1	6-8	8-9	15-18
Blue Blow Fly	500-700	0.5-1	7-9	7-11	15-21
Black Blow Fly	-	0.3-2	4-15	3-13	10-25
Flesh Fly	30-60 Larvae	-	4	4	8-16
Vinegar Fly	400-1000	1	5	2	8-11

RECOGNITION

Adults - the three major parts of the body are the head, thorax and abdomen.

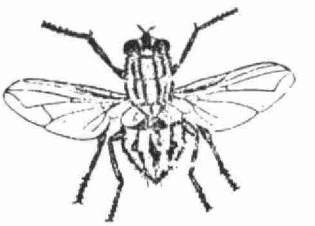
- the eyes, antennae, and mouth parts are located on the head.
- the three pairs of legs, the two wings, the squamae (lobes beneath the wings), and the breathing pores are located on the thorax.
- the shape of the fourth vein in the wing is important in the identification of flies.

Larvae - most larvae are pointed at the head (anterior) end and blunt at the rear (posterior) end. The distinguishing characteristic is the mouth hooks (black) that moves back & forth, at the front (pointed) end for typical Diptera. The shape and size of the breathing pores (spiracles) located at the posterior end of the larvae are used to identify fly larvae.

HOUSE FLY (Musca domestica)

Adults - dull grey flies with four stripes on the thorax, abdomen lighter colored than the thorax, fourth longitudinal wing vein sharply angled. Medium sized (about $\frac{1}{4}$ inch long).

Larvae - active, cream-colored, worm-like maggots, pointed toward head end, with large D-shaped breathing pores, about 3/8 to $\frac{1}{2}$ inch long.



House fly

Life Cycle

Female lays 5-20 batches of 75 to 150 eggs each. Egg to adult takes 7 to 45 days. Adults live 2 to 4 weeks in mid-summer, up to 10 weeks in cooler weather.

Larval Sources

Larvae occur in a wide variety of situations but are almost always in man-made sources. They are frequently encountered in all types of animal manures, waste animal foods, such as chopped green alfalfa and fruits and vegetables.

Adult Occurrence

Adults are common around larval sources and occur in and around houses. They are frequently attracted to man and domestic animals.
Prefer warm but not extremely hot weather. Occur in most areas from June to November. Usually abundant in September and October.

LITTLE HOUSE FLY (Fannia canicularis)

Adults - males are easily recognized by their habit of hovering in protected places. They are dull grey, with abdominal segments next to the thorax mostly yellowish. Similar in size to a house fly, but much less robust. In some areas a smaller, blacker, faster moving fly (Fannia femoralis) also hovers in protected places. Females are dull grey flies with no obvious specific characteristics.

Little house fly

Larvae - not white maggots like the other domestic flies but are flattened and brown with projections along the sides.

Pupae - very similar to the larvae and are frequently difficult to distinguish from them.

Life Cycle

Female lays six to eight batches of 30 to 70 eggs over a two-week period; egg to adult takes 18 to 24 days.

Larval Sources

Larvae have been found in almost all kinds of decaying, organic

matter including grass clippings and other plant material, fungi carrion, garbage, bird nests, mouse nests, bumble bee and wasp nests, and manure.
Chicken manure is usually the source responsible for large adult populations. Manure in pigeon nests is also an important source. Other types of manure, including dog droppings and old dairy manure, may also be sources.

Adult Occurrence

The males hover in protected places such as breezeways, open garages, front porches, and inside houses.

GREEN BOTTLE FLIES (two species of Phaenicia)

Adults - shiny green or coppery colored flies that are similar in size or slightly larger than house flies.

Larvae - have the spiracular area surrounded by tubercles, the peritreme complete and the outermost slits at an angle rather than horizontal.

Green bottle fly

Life Cycle (Phaenicia sericata)

Females lay up to 3,000 eggs in batches of 50 to 200. After hatching, the larvae feed for 3 to 7 days before crawling away from the larval source to pupate in the soil. Egg to adult takes 9 to 18 days.

Larval Sources

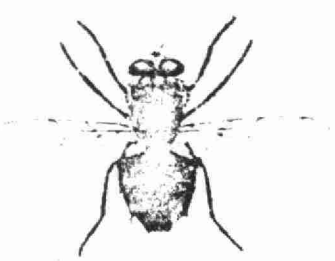
Garbage cans are the most important sources in urban areas. Cans with once-a-week garbage collection commonly produce 500 flies per can per week. Single cans have produced more than 30,000 flies in one week.
Larvae also occur in carrion and occasionally in manure.

Adult Occurrence

These are frequently the most common domestic flies in urban areas. Particularly important as a nuisance at outdoor barbecues. Common around garbage cans and on lawns and dog droppings.

BLUE BLOW FLIES (Eucalliphora lilaea)

Adults - bicolored flies, the thorax being grey with stripes and the abdomen shiny blue.



Blue blow fly

Larvae - have the spiracular area surrounded by tubercles, the peritreme complete, and the outermost slits horizontal.

Life Cycle

Female lays from 500 to 700 eggs. Larvae complete feeding in 4 to 5 days, with total larval period usually lasting about 13 days. Egg to adult takes 15 to 21 days.

Larval Sources

Carcasses of birds and small mammals are important sources. Uncovered garbage dumps may also be a source.

Adult Occurrence

Eucalliphora are much more abundant than other species. Blue blow flies are usually the first adult flies to appear in the spring.

BLOW FLIES (Phormia regina)

Adults - shiny black or green and similar in size or slightly larger than house flies. They are distinguished from green blow flies by the presence of orange anterior breathing pores.

Blow fly

Larvae - have spiracular area surrounded by tubercles and the peritreme incomplete.

Life Cycle

Females lay eggs in animal carcasses or garbage. The egg to adult cycle takes 10 to 25 days. Dog stools also are development areas for flies.

Larval Sources

Carcasses and garbage dumps are important sources. Larvae also occur in animal wounds.

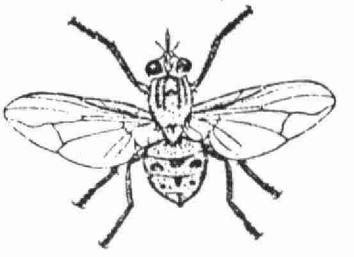
Adult Occurrence

This is one of the most common flies in wild situations. It is commonly attracted to carcasses and garbage dumps. Adults are active in the relatively cool temperatures of early spring as well as during the summer.

STABLE FLIES (Stomoxys calcitrans)

Adults - similar in size to house flies but have a sharp blood-sucking proboscis that is readily visible when the fly is resting. When resting, the body is at a slight angle rather than parallel to the surface.

Larvae - have two small pinpoint spiracles that are farther apart than their width.



Stable fly

Life Cycle

Females lay about 300 to 400 eggs in a two-week period. Eggs hatch in 1 to 5 days. Egg to adult takes 13 to 40 days.

Larval Sources

Manure, especially if mixed with straw, lawn clippings and waste feed, such as alfalfa, are important sources. Larvae may also be found in poultry manure.

Adult Occurrence

Common around dairies, however, the dairy is not necessarily the source. Occasionally attracted to and bite dogs in sufficient numbers to be a serious problem.

VINEGAR FLIES (Drosophila)

Adults - small, yellowish-brown flies, commonly associated with decaying fruit or vegetables.

Larvae - small and have a pair of processes on posterior end.

Vinegar fly

Life Cycle

Females lay 400 to 1,000 eggs. Eggs hatch in one day. Egg to adult takes 8 to 11 days.

Larval Sources

Decaying fruit and vegetables are main sources. Garbage cans may also be a source.

Adult Occurrence

Most abundant around larval sources. Commonly attracted to fruit and garbage cans. Most abundant in the fall but may be present throughout the year.

FALSE STABLE FLIES (Muscina stabulans)

Adults - similar in appearance to house flies but can be recognized by the pale or reddish color on the tip of the scutellum and the fourth longitudinal vein being only slightly curved upward near the tip of the wing rather than sharply angled. They are usually slightly larger than house fly adults.

False stable fly

Larvae - have large solid black spiracles without a distinct peritreme.

Life Cycle

Females lay 140 to 200 eggs that hatch in less than 24 hours. Egg to adult takes 15 to 18 days at 80°F.

Larval Sources

Larvae occur in manure and in decaying plant wastes such as fruit and vegetables. Under some conditions the larvae are predacious on other fly larvae.

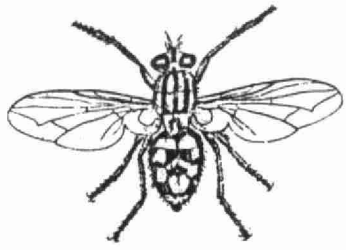
Adult Occurrence

Adults occur in many situations, and frequently enter houses. They are most common in the early spring before house flies become abundant.

FLESH FLIES (many species in the family Sarcophagidae)

Adult - dull grey flies and are distinguished by only three black stripes on the thorax instead of four. Abdomen usually has a checkered pattern. Males of many species have a red spot at the posterior end of the abdomen.

Larval spiracles are in a deep cavity.



Flesh fly

Life Cycle of Sarcophaga haemorrhoidalis

Females deposit 30 to 60 larvae instead of eggs. Larva to adult takes 8 to 16 days.

Larval Sources

Larvae occur in many situations. Some species develop in manure, other in dead animals, and some as parasites in other insects.

Sources commonly encountered in situations associated with man include garbage, manure (especially individual cow feces and dog droppings) and domestic or wild dead animals (including poisoned snails).

Adult Occurrence

Adults from both wild and domestic sources may be found in homes. Adult females that deposit larvae on meat may infest the meat with larvae even though it is exposed to the flies for a very short time.

CLUSTER FLIES

Of the several kinds of flies that attempt to overwinter in houses and other buildings, cluster flies are the most exasperating - big clumsy fellows that remind one a little of the awkwardness of puppies or calves. While they are not attracted to food as house flies are, they seem positively gifted in their ability to get into places they should not be - places the housewife insists they not be.

Overwintering flies in homes include, in addition to cluster flies, some house flies, cattle face flies, and a few other species - but cluster flies are the most abundant.

With the advent of central heating, the winter fly problem developed. Now all or most of the rooms in homes are heated and flies that have gained entrance into houses find it difficult 'to hibernate' and thus remain more or less active all winter. On sunny, windless days particularly, they tend to find their way to rooms and windows on the sunny side of the house.

Another factor that is responsible, in part at least, for the large numbers of flies overwintering in homes, is that the lumber used in home construction since the Second World War is not cured as adequately as it formerly was. Shrinkage of door and window frames, etc. permit ready entrance of the flies into wall spaces and from there into attics and rooms.

Description

Cluster flies are slightly larger and heavier than other flies usually found indoors. The general color is dark gray to almost black with no stripes obvious on the thorax (region between head and abdomen) and with a mottled or checkered dark grayish abdomen. Freshly emerged adults have crinkly, yellowish or golden 'hair' on the thorax; with older flies much of this will have been broken or worn off. At rest, the flies tend to overlap the two wings in a scissor-like fashion and these are held more or less parallel to the surfaces on which the flies are resting.

Life History

In the early spring when air temperatures approach 50°F, overwintering flies emerge from hiding places and endeavor to get out-of-doors. The flies feed on the nectar of early flowers and on maple sap and that of other trees. With warmer weather, mating takes place and soon after, egg-laying begins. Eggs are laid in crevices in the soil and in or near earthworm burrows. It is not thought that any are laid directly on the earthworm hosts. Hatching occurs in from three to five days. The larvae seek out earthworms, penetrate into their body cavity and feed for two or three weeks on the secretions present. When growth has been completed, the larvae leave the worm hosts and pupate in the soil. It is not known whether the parasitism always results in the death of host worms but a large proportion of the worms found on sidewalks and driveways in the morning after a rainy night are parasitized and act in this abnormal 'sickly' manner. Pupation usually requires about two weeks but many last as long as six. There are probably three or four generations each year and more farther south.

Habits

How long the flies live under natural conditions is unknown. Undoubtedly a proportion of those of the last generation survive the winter but the mortality is high. In the late summer or early autumn when the adults of the last generation have emerged, they seek shelter as day and night temperatures fall. In rural areas, they may cluster in holes in trees or in crevices of standing and fallen trees, under accumulations of leaves, etc., on the ground surface, or in barns and other buildings when available. In built-up areas, buildings of one kind or another provide hiding places. Common places for overwintering seem to be attics, wall voids and about window and door frames. In addition, large numbers are sometimes found in such unlikely places as behind pictures or baseboards, between drapery folds, the undersurfaces of furniture, under edges of carpets, in closets, chimneys, electric outlets and junction boxes, etc.

Temperature appears to control winter activity. Below 50°F the flies are seldom active. As temperature rises above this point they wander about and if they find their way into a room with a window, the light attracts them. When the sun begins to shed some heat, flies may be active almost every day on windows that face south or west.

Control

An overwintering fly problem is never an easy one to solve. It will require imagination and persistence and about the best one

can expect is that their numbers will be greatly reduced. It is very doubtful if the flies can be eliminated completely. The particular housewife will have to put up with a certain amount of frustration. She should not worry about what the neighbors are going to think; they have the same problem. The house has not been built yet that will keep all cluster flies outside. However, a number of things can be done that will greatly reduce their numbers.

Outside - By means of caulking compound, fill all the cracks and crevices around door and window frames and other small openings that will be revealed by a careful examination. Particular attention should be paid, too, to the area (soffit) between the evetroughing and the brick or stone wall; shrinkage here can leave a space between the wood and wall proper which will permit the flies to get into the attic or wall-spaces. A good caulking job is the best insurance against a cluster fly problem. The careful installation of quarter-round or cove molding over these cracks will be very helpful. The 'facer' board (fascia or facia), to which the evetroughing is attached, sometimes loosens, leaving a crack by which flies can get inside. Attic ventilation louvres should fit snugly and be tightly screened on the inside. The installation of weather-stripping will be helpful, also.

With the onset of cool nights in early September the flies tend to be attracted to barns, houses, and other buildings. A warm day, after they have found their way inside, will bring them out again. Sometimes part of a wall may be almost black with the flies. A residual spray, applied at this time or somewhat earlier, around window and door frames, eves and gables and also on those wall surfaces where they have been seen to congregate in previous years, will greatly reduce the numbers that will find suitable overwintering quarters and be a nuisance indoors during the remaining fall and the winter months. 2% chlordane surface spray is recommended.
Spray the areas to the point of run-off; upon drying, a toxic residue will remain.

Inside - Baseboards and quarter rounds should fit snugly where floors and walls come together. A commercial crack filler will be useful in this connection and also to close any cracks between wall surfaces and window or door frames. Keep an aerosol insecticide 'bomb' handy. Direct the stream of spray droplets so that they will hit flies at windows or flying about in rooms. Dead flies should be collected wherever they are found in a building. Accumulations of them, as in an unused attic, for example, will become attractive to larder and other dermestid beetles which

may become more serious pests than the cluster flies.

The dusting of an unused attic with a dust-form insecticide is also effective if a thorough treatment is given in the early autumn. This type of control calls for some type of hand duster. Such equipment and the insecticides also, are available at department, hardware, cooperative, and feed stores and such places as garden centres and nurseries. A thorough application of a 5% chlordane dust will cling to the rough lumber (rafters, sheeting, etc.) and also to plastered surfaces. It may be possible to introduce the dust into wall spaces; this should increase the effectiveness of the treatment.

ECOLOGY OF FLIES

The immature stages of flies may occur in almost any moist, decaying, organic matter. The most frequently encountered sources are listed below:

Agricultural Sources

a) Animal production:

1) Manure and waste feed produced as by-products of hog, poultry, beef and dairy cattle operations.

b) Crop production:

1) Crops left in field after harvest
2) Manure

Food Processing Wastes

Garbage cans, refuse disposal, etc.

REPRODUCTIVE POTENTIAL

Domestic flies have an extremely high reproductive potential. The development permits an extremely rapid increase in fly populations as soon as warm weather returns in the spring.

Improperly managed solid organic wastes can be responsible for the production of extremely large numbers of flies. Single sources such as an improperly managed poultry ranch or refuse disposal site may contain several million fly larvae at a given time. Possibly 100,000 adult flies per day could emerge from such a source. Fly control programs that depend on killing adult flies rather than preventing fly production are usually unsuccessful. If you kill 90% of the 100,000 flies that can be produced every day by a major fly source, you still have 10,000 flies a day added to the community.

FLY RANGE

Adult flies usually fly far enough to find sites suitable for feeding and egg laying. Most flies live within ½ mile of where they were hatched. Rarely do large numbers of flies travel more than 2 miles. Maximum recorded flight ranges for several species of domestic flies are given below:

Maximum Recorded Flight Range of Some Domestic Flies (in miles)

	24 hours	48 hours	Maximum
House fly (Musca domestica)	6.3	-	20
Stable fly (Stomoxys calcitrans)	5	-	5
Black blow fly (Phormia regina)	3	15.5	28
Green blow fly (Phaenicia sericata)	-	3.5	5
Green blow fly (Phaenicia cuprina)	2.5	5	5
Vinegar fly (Drosophila melanogaster)	6.4	-	6.4

The direction of the prevailing wind has very little effect on the direction of flight. Flies may fly upwind toward an attractive odor during gentle winds but are seldom carried downwind because they do not fly in high winds.

MANAGEMENT OF SOLID ORGANIC WASTES (SANITATION)

Successful fly control depends on the prevention of fly production by the elimination of habitats (sources) suitable for the immature stages rather than killing the adult flies after they emerge. This involves an adequate system of collection, storage or processing, and disposal or utilization of the solid organic wastes that produce flies. The following recommendations for the management of common fly sources are presented as examples of what is necessary in order to prevent fly production.

Garbage cans are usually the most important sources. Green bottle fly production can be reduced substantially by the use of garbage grinders, twice-a-week garbage collection, and keeping cans clean by lining with newspapers, wrapping garbage, and cleaning the cans whenever necessary.

Grass clippings may be an important fly source if they are kept in a moist pile and allowed to decompose until they are slimy and stain the fingers. This usually requires more than two weeks, so they should be removed at least every other week.

Compost piles may produce flies if they are not turned often enough to maintain the composting at a rate that is sufficiently rapid to prevent fly production.

Snails that have been killed by snail poison are frequently a source of flies, especially flesh flies. They should be picked up at least once a week.

Pet droppings may be a source of many kinds of flies. Even cat droppings that are covered may produce flies if many droppings are buried at the same place. Regardless of the importance of pet droppings as sources of flies, they are extremely important as a fly attractant. Homes with pets usually have many more adult flies in the yard than homes without pets.

Fertilizer (especially chicken and cow manure) may contain fly larvae or pupae that emerge after the fertilizer is applied, or flies may actually go through a complete life cycle after the fertilizer is applied if it is not broken up or mixed into the soil.

Backyard animals require careful management, including weekly manure removal.

Dairies:

The house fly is the most important species, but stable flies and other species may be important in some dairies.

The most important sources are manure and bedding in calf pens, manure in corrals along feed trough areas, manure under fences,

piled manure and waste feed.

Important management practices include:

- removal of manure and straw from calf pens at least once a week
- scraping manure from area along feed troughs at least once a week
- removal of wet decaying feed before flies are produced, and
- maintaining good drainage during winter so manure can be removed soon after winter rains.

EXCLUSION OF FLIES

Flies may be excluded by the methods discussed below. Exclusion of flies may relieve a particular fly nuisance, but it usually does not solve the fly problem (screening of poultry houses and fly tight storage are exceptions).

Screens with 16 wire strands per inch in each direction (16 mesh) are recommended for windows and doors of houses and restaurants in order to exclude flies such as house flies and blow flies. In order to exclude smaller flies such as vinegar flies, screens with 24 wire strands per inch in each direction (24 mesh) should be used. Screened poultry houses not only prevent flies from entering the houses in order to lay eggs in the manure but they also prevent the escape of flies that are produced in the houses. These trapped flies can then be killed with an insecticide. Further information on the construction and management of screened poultry houses can be obtained from the University of California Agricultural Extension Service bulletin on Poultry House Screening for Fly Control.

Fans may be useful in preventing flies from entering doors that are opened frequently or remain open. They do not keep out every fly, but they should keep out at least 80% of the flies, and they certainly provide better protection than an open door. Normally, the air is released at the top of the door and moves downward. It is desirable for the air to be released along the entire width of the door. Two types of fan systems are recommended:

1) Barriers with an air velocity of more than 1500 feet per minute (17 miles per hour) measured 3 feet above the floor. These fans are not suitable for customer entrances because of the high air velocity. Usually they direct the air outward instead of returning the air.

2) Barriers with a deeper column (usually more than one foot) of air moving at a lower velocity. The air is usually collected and reused. These air barriers may be used for customer entrances.

Fly-tight storage will prevent the emergence of adult flies from a source infested with larvae as well as preventing additional egg laying. Air-permeable, saran mesh tarpaulins are recommended for covering manure because they allow the manure to dry out.

TYPES OF INSECTICIDES USED FOR FLY CONTROL

Long-lasting (residual) surface spray insecticides are usually the most effective and economical.

Quick knockdown surface sprays provide an immediate reduction in the number of adult flies but are usually more expensive because their short residual life requires frequent applications of the spray.

Baits and insecticide-impregnated strips or bands are useful in some situations such as screened poultry houses.

Space sprays (pyrethrum) only kill flies that are hit by the spray and have no residual effect.

Larvicides are not recommended for general use:

1) It is difficult to get adequate penetration of the insecticide into the organic material in which the larvae occur.

2) Parasites and predators that occur on and in the manure are very susceptible to most insecticides.

3) Resistance builds up quicker when both larvae and adults are exposed to the same insecticide.

Meat Processing Plants

Residual sprays are not permitted in rooms containing exposed meat because of the danger of dead flies contaminating the meat. Pyrethrum is permitted if the exposed meat is removed before spraying and the room cleaned by thorough washing after application of the insecticide. Get approval from the Canada Department of Health, Food Inspectors Services, before applying an insecticide in a meat processing plant.

Garbage Containers

Adult green bottle flies in urban areas probably came from garbage containers, but in most situations they may have come from many containers over a considerable area rather than the container on the premises where the adults are a problem. Consequently, the use of insecticide inside a garbage container may lower the number of flies produced in that

individual container but will seldom lower the number of adult flies on the property. Twice-a-week garbage collection and maintenance of clean containers or the use of garbage grinders throughout the community is necessary in order to provide adequate fly control.

Use of DDVP strips inside garbage containers will reduce oviposition by killing the adult green bottle flies that enter the containers, but they are not recommended for widespread community use because this method of application would probably encourage rapid development of strips to the lid of the container; and the strips are effective for about five weeks during the summer, so at least two applications would be necessary each year.

Homes

Pyrethrum plus synergists is the insecticide recommended for use inside homes.

Outdoor space-spraying is not recommended because it only kills the adult flies actually contacted by the insecticide, resulting in a rapid reinfestation of the area.

CHAPTER VIII

OCCASIONAL HOME INVADERS

INTRODUCTION

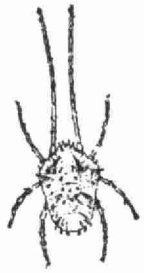
Occasional home-invading pests refer to the many insects that either live outside of homes and occasionally invade buildings, or those that complete most of their life cycle inside buildings. Some of them are capable of causing extensive damage to household furnishings and goods. Others are simply nuisance pests because of their presence. Because the method of control for each of these pests is rather specific, it is important that the problem be correctly diagnosed and properly treated.

Clover Mites (Bryobia practiosa)

Clover mites often invade homes during the fall, winter, or spring. They are a nuisance, do not bite man, and may cause stains when crushed. During unfavorable feeding conditions, such as draught, warm or cold weather, the mites begin to move and may be found on the south and/or west side only, both inside and outside the house. They are apparently attracted toward the warm, moist air inside the house and enter through cracks along baseboards, doors or windows.

Recognition:

- The clover mite, even though about the size of a pin head, is one of the largest of the mites. It is recognized by its two front legs extending forward as long or longer than its body. Color varies from reddish-brown to green; legs are amber or orange. The young clover mites are bright red.



Clover mite

Life Cycle:

- Females lay bright red eggs singly or in masses under window sills, foundation cracks, under the bark or limbs of trees.

- Eggs hatch during the spring and fall primarily. At temperatures above 85°F the eggs remain dormant and do not hatch.

- The newly hatched mites move to grasses, clovers, and other plants to feed. After feeding, the mites return to their hiding places to molt. They feed and molt three times before becoming adults.

- Three to five generations are produced each year. All stages may be present in the winter. They hibernate in hiding places.

Remarks:

- Clover mites feed by piercing and then sucking plant juices. They feed upon lawn and wild grasses, clovers, weeds and other plants. Newly planted lawns seem especially attractive.

- Clover mites tend to feed within a few feet of their hiding places, usually close to house foundations, tree trunks or rock walls. Mites are active at temperatures of 50° to 70°F. in the micro-environment; thus, on the south wall of a house they may be active even on a cold winter day.

Control:

- Outside - Remove or dig in the sod in a strip two feet wide against the foundation. Flowers and evergreens may be planted in this area. This will not eliminate the mites from the house quickly but is the only permanent method.

- To clean up an infestation more quickly, also apply a spray to the outside of the wall up to the windowsills and to the lawn within 15 feet of the house. Several miticides are effective. Since malathion is readily available and is safer to use than most other miticides, only it is listed here. Use ½% malathion spray made as follows:

  Malathion 50% emulsion 2 quarts or 25% wettable powder 8 pounds
  Water 40 gallons

  For 1 gallon of spray add 10 teaspoonfuls of the emulsion or 20 tablespoons of wettable powder to 1 gallon of water. Apply to wet the wall and lawn thoroughly on a warm day.

- Do not apply to Canaertii junipers or petunias as this spray will injure them.

- Use the vacuum cleaner on windowsills. If used on wallpaper it may squash the mites, leaving a stain. Aerosol sprays (push-button pressurized cans) will kill mites that are actually hit by the spray. Light oil rubbed or sprayed on wood will kill and repel clover mites.

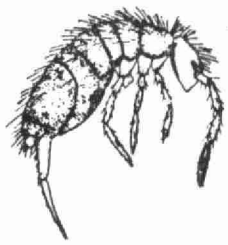
Springtails (order Collembola)

Springtails are very primitive wingless insects of simple anatomy, that probably closely resemble the ancestral stock of all insects.

They mostly live outdoors but frequently can occur in homes. They do no damage and are a nuisance only because of being present in large numbers.

Recognition:

- Springtails are small, usually only a few millimeters in length. Adults vary from white or slate to brightly metallic colors. The adults are globular rather than cylindrical in shape, and the mouth parts are below the head. A forked appendage attached to the underside of the abdomen can be suddenly released, enabling the insect to leap straight into the air. This behavior gives them their name.



Springtail

Life Cycle:

- Eggs are laid singly or in groups of five to one hundred, in soil or humus, under bark, leaves, stones, rotten wood, and in similar places. The young develop by simple metamorphosis.

Remarks:

- Springtails eat decaying plant and animal matter, fungi, algae, diatoms, and can feed on living plants.

- They prefer damp places and are found around bathroom and kitchen sinks and tubs, drains, moist walls and basements, moist flower beds and humus piles.

Control:

Sanitation

- Measures that will eliminate moist places where springtails hide or breed will help in controlling them. Remove humus and trash piles in the yard. Proper ventilation of humid areas or removal of boards and other materials in contact with damp floors will help.

Chemical Control Outside

- Damp areas around swimming pool aprons, moist flower beds, damp sub-areas, and humus piles should be sprayed or dusted. Materials that can be used are lindane, malathion, and carbaryl (Sevin), which appears excellent when used in granular form against this pest.

Chemical Control Inside

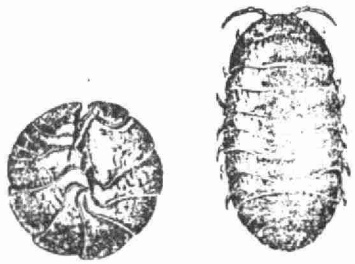
- Treat wet surfaces, such as bathroom overflow drains, water pipes, and other places where springtails are seen. In some cases, they may be found around light fixtures. Oil sprays will not adhere to wet surfaces, so use dusts or emulsions instead. Lindane, diazinon, chlordane, and malathion can be used.

Sowbug and Pillbugs

Sowbugs (Porcellio laevis) and pillbugs (Armadillidium vulgare) are found throughout Canada and feed primarily on decaying organic matter, although some occasionally damage roots of green plants. Primarily found outdoors, they wander indoors at times where they do no damage. These dooryard pests are related to shrimps and crabs and are not insects.

Recognition:

- Sowbugs are oval, segmented, brown or grayish in color and measure up to ½ inch long. Sowbugs have two short, but prominent tail-like appendages, seven pairs of legs, and most species have well developed eyes. Pillbugs are similar except that they lack the tail-like appendage and roll up into a tight ball when disturbed.



Pillbug

Life Cycle

- Breeding can occur throughout the year, but is most frequent in the spring. The eggs, numbering up to 200 or more in a brood, are carried by the female in a brood pouch on the underside of the body. The eggs hatch in three to seven weeks, and the young remain in the pouch for about six or seven weeks. It takes the young about a year to mature. Individuals may live for three years. They are inactive during cold weather, although they may be found in basements during winter months.

Remarks:

- Sowbugs will feed on any soft, moist vegetable matter and they are often attracted to over-ripe fruits on the ground. They feed principally on decaying organic matter such as flower bed mulches, grass clippings, and leaf litter. Some attack the new roots and tender stems of growing plants and can become nuisances in greenhouses.

- Since sowbugs and pillbugs breathe by means of gills, they require moist conditions to survive and are most active at night. They can be found under trash, rocks, boards, under decaying vegetation, such as accumulations of grass clippings or bag mulch, or just beneath the surface of the soil. They also hide in crevices in dark, damp basements. Some species can survive dry conditions for a few hours or perhaps a day. During extended dry periods, sowbugs will burrow deep into the soil if water is not otherwise available.

Control:

Sanitation

- Removing hiding places, food materials, and moisture sources will help to prevent infestations. Basements should be ventilated to eliminate excess moisture. Piles of leaves, grass clippings, mulch in flower beds, fallen fruit, and dog droppings, all of which provide moist hiding places, should be removed.

Chemical Control Outside

- Outside treatments should be made to and near foundation walls, around and beneath door steps and porches, weep holes in brick facing, around pools, subfloor crawl spaces, and damp areas immediately around structure. For successful control, outdoor treatment is always necessary.

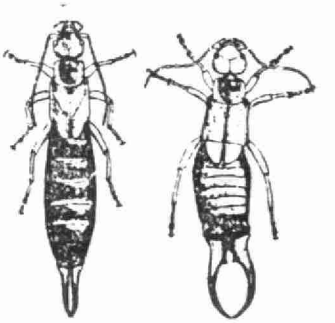
- Almost any of the common insecticidal dusts can be used, but 5% or 10% carbaryl or 10% chlordane is favored for sowbugs. Crawl spaces and weep holes are places where dusts can be used most effectively. Granules or 5% chlordane (10% diazinon, 5% carbaryl), at the rate of 4 or 5 pounds per thousand square feet are useful for treating lawns. For a more thorough coverage, power spraying of the yard is recommended, with the use of wettable powders of carbaryl, chlordane, diazinon, or malathion. Pay particular attention, when spraying, to organic mulches in flower beds.

Chemical Control Inside

- Treat indoors when sowbugs are actually breeding inside as in damp basements or within hollow foundation walls. Baseboards, bath traps, and any other voids or openings in floors at or near grade level require treatment. Dusts of 5% or 10% chlordane, carbaryl; and residual sprays of 0.5% lindane, 1% Baygon, 1% diazinon, or chlordane are effective.

European Earwig (Forficula auricularia)

Earwigs are common insects which occur in or about homes, yards, and gardens. Earwigs cause concern because of their appearance but they are harmless, cannot sting, and are not able to bite or pinch hard enough to cause any injury to the skin of people. The European earwig is the common species in Ontario.



European earwig

Recognition:

- The European earwig is dark reddish-brown with a reddish head, about ½ to 1 inch long and is easily recognized by the prominent forceps or pincers at the rear. The young are much like the adults.

Life Cycle:

- In the spring, the female lays a batch of about 30 eggs in cells beneath the soil surface. The eggs are brooded by the female.

- After hatching, the female stays with the nymphs, keeping the nest tightly closed to prevent their escape. After molting once, the young nymphs disperse.

- Four nymphal stages occur before adult maturity is reached in 68 or more days. There is usually only one generation per year.

Remarks:

- Earwigs eat almost anything they can chew but prefer plant food and may cause damage to garden plants.

- Earwigs hide in large numbers in the yard under stones, boards, mats, boxes, newspapers, and in the crotches of trees. They invade homes, infest bedrooms and closets. The adults are winged and can fly, but rarely do so. They are active mainly at night.

Control:

Sanitation and Exclusion

- Since earwigs like moist hiding places, the removal of damp piles of papers, boxes, lumber, carpets, and other places they may hide, will help reduce their numbers.

- They can be excluded from homes by weather-stripping doors and windows and sealing all exterior cracks and openings.

Chemical

- Earwigs must be controlled outside the house to effect a permanent cure. Power spraying of the yard areas with chlordane, diazinon, carbaryl, or malathion will help. Granules of chlordane or carbaryl may be even better.

- Earwigs inside the house can be controlled by spraying or dusting moldings and other hiding places with diazinon or malathion.

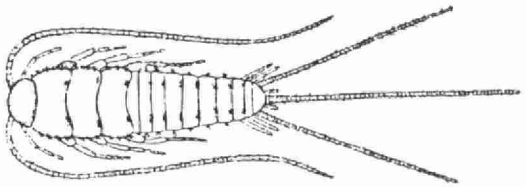
Silverfish and Firebrats

Silverfish and firebrats belong to a primitive group of insects of characteristic appearance, being flattened and carrot-shaped, broad near the head end and tapering toward the rear. They are scaly and wingless and have long slender antennae. The body of an adult silverfish is covered with scales which may give either a uniformly silver appearance, as is the case with silverfish, or a gray, mottled condition, as with firebrats.

Recognition:

- Silverfish, Lepisma saccharina, are uniformly silver to brown, about ½ inch long.

- Firebrats, Thermobia domestica, are mottled grayish brown, about ½ inch long.

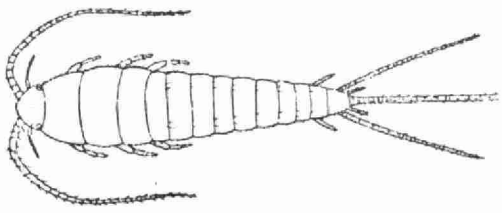


Firebrat

Life Cycle:

- Both silverfish and firebrats develop by simple metamorphosis.

- Silverfish females lay up to 100 eggs in cracks and crevices. Eggs hatch in two to eight weeks depending upon conditions. After three to four molts the nymphs develop adult coloration. Silverfish take three to four months to become sexually mature and may live for three to four years.



Silverfish

- Firebrat females lay up to 50 eggs in cracks and crevices. Because of the warmth, the eggs hatch in 12-13 days. Nymphs are sexually mature in two to four months and full grown in a year. Adults may live up to two years.

Remarks:

- Silverfish live in damp areas indoors or out, usually underneath boxes, boards, debris, etc. They may enter homes by being carried on cardboard cartons, books,

old papers or through house vents. They are active both day and night.

- Firebrats prefer very warm areas indoors where temperatures are above 90°F. Indoors they are usually found near heating units, fireplaces, and steam or hot water pipes if these areas are not too dry. Firebrats require some moisture.

- Both species feed upon starches and proteins, such as fabrics, paper, starches, glue, books and other household furnishings. They leave yellowish stains, especially on linens.

Control:

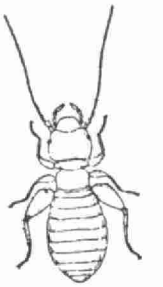
- Residual sprays or dusts should be applied to all hiding places, such as cracks and crevices in basements, cupboards, closets, behind baseboards, around heaters and warm pipes. Chlordane, diazinon, dichlorvos, lindane, Baygon and silica gel should yield good control. Some "bristletails" may live entirely within the wall void and thus might not contact the usual residual materials; in this case, dichlorvos, Baygon or lindane may be useful. Kepone baits are useful in situations where sprays or dusts cannot be used.

Booklice (Psocids)

Booklice (Psocids) areminute household pests that are usually not harmful but may be annoying because of being present in large numbers. They may sometimes be recognized by their jerky way of running.

Recognition:

- Psocids measure only 1-2 mm, are soft bodied, flattened and wingless. They are yellow to brown in color. They have rather long antennae and chewing mouth parts.



Booklice

Life Cycle:

- Psocids develop by simple metamorphosis.

- Growth and development of the egg depends upon temperature and may take 6 to 21 days.

- Nymphs pass through four molts and resemble adults in appearance but are not sexually mature.

Remarks:

- Psocids prefer damp, warm, undistrubed situations such as under the bark of trees, or seldom used cereal products. They normally live outside but may be found in furniture and stored food products.

- These small insects feed particularly on materials of plant origin such as molds, fungi, cereals, or other milled products. Any damage they do is restricted to contaminating stored food products.

Control:

- If you find a few booklice in your home, you can probably get rid of them by cleaning your house thoroughly and by sunning, drying and airing the infested rooms. If they are abundant, find their breeding places and remove them. In new buildings, use the central heating system to dry out the rooms. This prevents or slows down the growth of the molds that provide food for the insects.

Chemical Control

- Residual sprays are useful. Apply an oil-base spray containing one of the following - 2% chlordane, 0.5% diazinon, 0.5% lindane or 2% malathion - to infested surfaces. These sprays may be purchased ready to be used, or can be prepared from concentrates, diluted according to directions on the label.

Centipedes (class Chilopoda)

Centipedes are long, many-legged pests, found in arid climates. They are not insects. They do not damage food supplies or household furnishings and do eat insects that are harmful.

Recognition:

- Centipedes are brownish, greyish-yellow to green, with a flattened worm-like, many segmented body. They are divided into two regions: head and abdomen.

- They have many legs, 15 to 100 pairs, one pair on each body segment. The claws of the appendages of the first abdominal segment (maxillipedes) have poison glands. Some centipedes can inflict painful bites, but none are lethal to humans.

Centipede

- Antennae are long.

Life Cycle:

- Centipedes develop with simple metamorphosis. The female lays 15 to 35 eggs in loose soil and watches over her young.

- They may live from five to six years.

General Characteristics:

- Centipedes live outdoors in moist areas under leaves, stones, and trash. They wander into houses and may be found any place that will give them cover. They are active at night and fast moving.

Control:

- Remove outdoor harborages, such as rocks, boards, and decaying vegetation.

- Apply insecticides at points of entry (cracks and openings at foundations, etc.) near grade level.

- Spray a wide band around an infested house, or spray concentrated narrow band. Chlordane (2%), and Sevin (2%) are used as well as dusts of chlordane (5%) and Sevin(10%). Emulsions and wettable powders of chlordane (2%), lindane (1%), and malathion (2-5%) have been reported to be used outdoors.

- Indoors, malathion (2%) or diazinon (0.5%) are used. Dusts of Sevin (10%) are useful for wall voids and crawl spaces.

- Modification of construction to eliminate damp areas will make houses less attractive to centipedes.

Millipedes (class Diplopoda)

Millipedes are arthropods, but not insects, and are found in nearly all temperate climates. They do not damage food supplies or structures, and cannot bite or sting.

Recognition:

- Millipedes are brown to purple in color, worm-like in appearance, from $\frac{1}{2}$ to 3 inches in size.

- They are divided into two regions: head and abdomen. Except for the third and fifth abdominal segments, they have four legs per abdominal segment.

Millipede

- Millipedes have short antennae and comb-like mouth parts.

Life Cycle:

- Millipedes develop with simple metamorphosis, live four to five years and adults overwinter in soil.

- Females lay 20 to 300 eggs.

General Characteristics:

- Millipedes live in moist, decaying material. They are nocturnal and slow moving.

- Food consists of decaying vegetable matter, tender roots and green leaves. Some millipedes will damage leafy plants.

Control:

- Remove harborages and decaying vegetable matter when practical. Explain to customer that organic mulch around flowers near house encourage millipedes and that spray may eliminate infestation immediately.

- Treat 10-foot swath around house when possible, getting insecticide down to soil surface. Check for migration from other properties and spray accordingly.

- Outdoors, diazinon (0.5%) and Sevin (1-2%) in emulsions or suspensions, and water base sprays of chlordane (2%) and lindane (0.5%) are used. Two to five percent malathion may be useful. Use label recommendations for control of turf pests.

- Indoors, dusts of diazinon, chlordane, Sevin and Baygon are used.

Crickets

There are two common species of cricket that may invade houses in late summer and fall. The house cricket is gray and the field cricket black. The illustration will assist in identification, as will the chirp of the male.

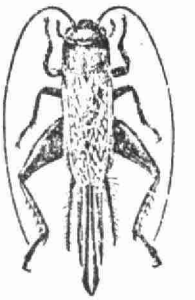
The black field cricket is more likely to invade houses in new subdivisions where there are fields of hay or grass nearby. The gray house cricket may be a problem in areas built on or near new fill. House crickets are usually associated with garbage disposal.

Crickets may cause direct damage in the home as they may eat fabrics.

Life Cycle:

- Crickets lay their eggs singly at shallow depths in the ground in late August and September. They may lay anywhere from 150 to 400 eggs. Most of the eggs overwinter in the ground and hatch in May and June.

- The newly hatched cricket can walk, run and jump immediately. It passes through from 8 to 10 instars before becoming an adult in 78 to 90 days. Hibernation occurs in the egg stage and, to a lesser degree, in the nymphal stage in the 5th and 6th instars.



Cricket

- Adults appear in July and August, mate, and usually die when the first cold weather sets in.

Control:

- If possible, control them outside. With the field cricket, it may be advisable to apply a poison bran bait from the house out 100 feet or more into the area where the crickets are numerous. With the house cricket, if garbage disposal is discontinued near the area, the crickets should not return the second year. In a year when they cause trouble, apply the poison bran bait as suggested for the field cricket. The bait may be prepared as follows:

  12 pounds of bran
  ½ pound of sodium fluoride
  about a pint of molasses
  about 1 gallon of water

  Add the molasses and sodium fluoride to the water, stir thoroughly, pour it over the bran and mix on concrete, using a hoe or shovel. Spread thinly by hand when the mixture is moist but not wet and wear rubber gloves while spreading the bait. If you have any unspread bait, burn or bury it immediately and wash all containers, as sodium fluoride is poisonous.

CHAPTER IX

POWDER POST BEETLES

INTRODUCTION

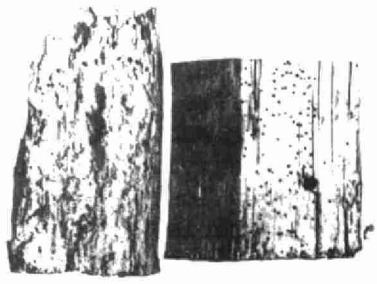
In Ontario there are a number of different kinds of insects which cause damage to seasoned wood. Of these, the powder post beetles are the most widespread and important. The eastern subterranean termites are also important pests of seasoned wood in restricted areas of Ontario. Carpenter ants, although occurring over most of the province, are seldom as injurious as powder post beetles or the eastern subterranean termite. In addition to these insects, the wharf borer and a few other species are occasionally injurious.

The common name "powder post beetle" is loosely applied to several species of beetles, the larvae of which cause a similar type of damage to seasoned wood. These insects have comparable life histories and can be controlled by the same methods.

DAMAGE

The first evidence of powder post beetle injury may be the appearance of small exit holes (about the size of a pinhead) where the beetles have emerged through the surface of the wood. In some cases, the first indication may be the presence of fine, sawdust-like 'frass' dropping from the tunnels made by the larvae as they burrow in the wood. In the majority of farm buildings air currents scatter the frass so that it is rarely noticeable except in sheltered places or where it is caught in spider webs. Successive generations of larvae gradually reduce wood to a spongy network of frass-filled tunnels. The damage is most extensive just below the surface. The surface of infested wood, except for the presence of exit holes, may have the appearance of sound wood.

As the infestation progresses, the larvae burrow deeper into the solid wood until its structural value is destroyed. In whitewashed buildings, the whitewash may obscure the exit holes and other evidence, making the detection of damage more difficult.



Powder post beetle damage

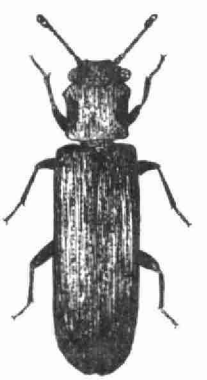
LIFE HISTORY

Adults (beetles) are seldom seen by the casual observer. They are small, 1/5 inch or less in length and are usually reddish-brown to black in color. They emerge from infested wood, usually during the period from early May to mid-July. The time of emergence varies with local conditions, mainly of temperature and humidity. After emergence the beetles move about and mate. They fly quite readily and often congregate at windows. After mating, the females may lay 40 to 90 eggs in the pores of the wood, in rough surfaces, in small cracks, old exit holes of the beetles, or even in tight-fitting joints between adjacent wooden members. The eggs hatch in from one to three weeks. The young larvae commence feeding on the wood, forming tunnels beneath the surface. Larvae resemble miniature white grubs and remain in the wood, feeding and tunnelling until full-grown which, in some species, may be in three or four months, or a year or more in other species. The length of the larval period varies not only with the species and environmental factors, but also with the suitability (as food) of the wood on which they are feeding. When full-grown, the larvae pupate in oval chambers just beneath the surface of the wood at the ends of burrows. After emerging from the pupal stage the adult beetles make small exit holes to the surface. Often in emerging the beetles will push piles of frass to the surface around the exit holes. In farm buildings there may be one generation per year or a generation may require several years under adverse conditions. The generations often overlap so that some beetles may emerge every year.

TRUE POWDER POST BEETLES (Lyctus)

True powder post beetles cannot digest the cellulose of wood, but feed upon the carbohydrate content. They are usually found attacking sapwood of various species of hardwoods, but sometimes may enter the heartwood. They seldom attack wood with more than 40% or less than 6% moisture and prefer sound wood which has been inadequately seasoned. They are not as prone to attack old wood as are other types of powder post beetles.

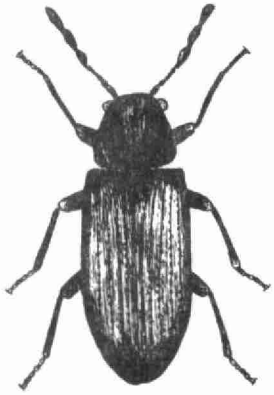
The cylindrical eggs are pushed into the end grain or pores of the wood. The size of the pores varies in different kinds of wood and limits the species of beetles which can attack a particular kind of hardwood. As a rule, the true powder post beetles complete their life cycle in three to eight or nine months. The starch content of the wood affects the duration of the life cycle. Wood cut in February has a higher starch content than wood cut in the summer and is more favorable for the development of the true powder post beetles. The commonest structures attacked are hardwood floors, tool and implement handles and other equipment of a similar nature.



True powder post beetle

THE FURNITURE BEETLES (The Common False Powder Post Beetles)

The beetles of this group are widespread in Ontario and may cause serious damage to farm and other buildings, furniture, and other wooden equipment. They will attack almost any type of hard or soft wood. As these beetles can digest the cellulose of the wood by means of enzymes, they are not dependent upon the starch content. They may attack both sap and heartwoods. Some species of these beetles prefer old to new wood. This preference is partially due to the presence of fungi in the wood, the fungi serving as a source of protein. In farm buildings they may require one or two to several years to complete their life cycle.



Furniture Beetle

COSSONID WEEVILS

Although these beetles cause damage similar to that caused by powder post beetles, they are seldom of importance in Ontario. They are usually smaller than other powder post beetles and have the head elongated to form a short, blunt snout. They attack the sapwood and occasionally the heartwood of both hard and soft woods. Damage, when severe, is usually associated with or follows decay and is commonest in flooring and subflooring subject to high atmospheric humidity and/or inadequate ventilation.

CONTROL

Prevention:

Wood infested with powder post beetles should not be used in structural repairs or alterations, unless it has been treated to kill the insects. This may be done by fumigation by a licensed operator, or by kiln drying. Thorough surface application of chemicals used for the control of these insects in existing buildings is of value in treating wood to be used in structural alterations, but if such wood is infected it will not entirely remove the danger of the infestation spreading to adjacent wood.

Infested untreated wood (even if to be used as firewood) should not be stored in buildings or be left near buildings for extended periods of time, especially from April until August when beetles emerge and may infest adjacent wooden structures.

Chemical Control:

Remove all bark and whitewash to facilitate penetration. Where practical, remove spongy and dry rot wood and replace it. Apply the spray under low pressure from between 20 to 30 pounds to reduce the amount of mist. Apply at the rate of 1 gallon per 100 to 300 square feet, depending on the nature of the wood. Apply several times as long as the spray will continue to soak into the wood. Treat all wood even though there is no external indication of infestation. Use oil-base sprays as they penetrate better.

Time to Treat:

The adults emerge from the wood in late May and early June. Therefore, treat barns in May as soon as the cattle are on pasture. In basements, treat at a time when the windows can be left open for ventilation.

What to Use:

Pentachlorophenol or copper naphthenate are the two materials recommended. Use one of:

(1) 5% pentachlorophenol in an oil base. This is available from lumber and insecticide dealers either as a ready-to-use 5% oil spray or as a concentrate of 20 to 25% to be diluted in fuel oil, diesel oil or kerosene to the 5% level. For use in the home, obtain a grade that will not stain the wood objectionably and one where a suitable finish can be used over the treated wood.

Caution - Pentachlorophenol is irritating to the eyes, skin and respiratory system, necessitating the use of full face respirators, rubber gloves and protective clothing during application.

(2) 2% copper naphthenate as an oil spray. This is likely to be available only as the 2% material. It will give a greenish color to treated surfaces.

Caution concerning fire - Since these materials are available in an oil base, fire precautions must be taken during spraying. Do not smoke, and cut electric current to the area being sprayed to avoid a flash fire.

Do not contaminate feed, hay, mangers, water bowls or water tanks in barns.

Treatment of Hardwood Floors:

Infestations of true powder post beetles in finished hardwood floors may be controlled by the application of 5% pentachlorophenol in an oil base, under low pressure, with the spray nozzle held 4 to 6 inches from the floor surface. All surface frass should be removed before the pentachlorophenol is applied. Using a brush or mop to apply the chemical

is not recommended as such methods of application with some oil base sprays tend to mar the finish of the floor.

In applying the spray, start in one corner or at one side of the area to be treated and apply the spray systematically, finishing spraying at an exit. Avoid walking on the sprayed surface.

The room should be closed until the oil base spray has evaporated and the floor is dry. Care should be taken to apply the chemical thoroughly without flooding the cracks between boards or causing puddles.

As different floor finishes react differently to oil solutions, it is advisable to test the spray on a small, inconspicuous area to observe the result before the whole surface is treated.

Floors kept thoroughly waxed are less subject to injury as the beetles will not lay eggs on finished surfaces.

Fumigation and Treatment of Furniture:

Although powder post beetles can be controlled y fumigation, this method, to be effective in the average building, should be carried out under tarpaulins (over the entire building). Fumigation has no protective value. It is a useful means of controlling powder post beetles in furniture, wooden equipment, etc, as these may be fumigated under tarps or in vaults. In Ontario all fumigation must be done by licensed personnel.

CHAPTER X

RODENTS

INTRODUCTION

The domestic rodents have been associated with man for several centuries, living on his foods and wastes and in his structures. These rodents have caused more human death and misery and economic damage than any other group of vertebrates. For these reasons man has attempted to control their numbers.

The three species of domestic rodents, the Norway rat (Rattus norvegicus), roof rat (Rattus rattus), and house mouse (Mus musculus), were introduced into California from the Old World. After their large-scale introduction during the Gold Rush, they have followed man into almost all areas of the state.

Control of domestic rodents involves denying their access to food and harborage and killing them with poisons, traps, and fumigants. Denying access to food and harborage makes a permanent reduction in a rodent population while killing them only makes a temporary reduction, since the survivors rapidly replace their numbers by breeding.

Norway Rat (Rattus norvegicus)

- This is the largest of the rats in Canada. Adults weigh 12 to 20 ounces and measure 7½ to 10 inches head and body length. The tail measures 6 to 8½ inches.
- It is distinguished from the roof rat by smaller, coarser, close-set ears; a darker above and lighter below tail, usually shorter than the head and body; and a blunt muzzle.
- The fur is coarse, grayish-brown on the back and grayish-white on the belly.
- Droppings are large (3/4 inch) and capsule-shaped.
- Litter size averages 8 to 9 young.
- A female has 2 to 4 litters in her lifetime.
- Life expectancy is 9 to 12 months.
- Home range is usually within an area of 100-200 feet in diameter. Norway rats usually find all necessary living requirements within a city block.
- Norway rats eat almost anything (omnivorous) but prefer garbage, meat, fish and cereal grains. The daily requirement is 3/4 to 1 ounce of dry food and ½ to 1 ounce of water.

- Norway rats live about residences, stores, warehouses, slaughterhouses, barns, pigpens, chicken yards, on garbage dumps, in sewer systems, coastal salt marshes, along banks of streams and ditches and in rice fields. They prefer to live near a source of water, although this is not a strict necessity. They also tend to construct burrows wherever they are found, occur at ground level and have good climbing ability.

Roof Rat (Rattus rattus)

- Roof rats are smaller and more lightly built than Norways. Two color phases are found in Ontario: black rats, which are sooty black above and gray below and Alexandrine rats, colored grayish-brown above and grayish-white to yellowish-white below.

- Roof rats have rather large, membranous ears; unicolored tails, generally longer than the head and body; and sharply pointed muzzles.

- Adult rats seldom exceed 8-10 ounces and measure 6 to 8½ inches in head and body length. Tails measure 7 to 10 inches.

- Droppings are medium size (½ inch) and spindle-shaped.

- Litter size averages 5 to 7 young.

- A female may have 2 to 4 litters in her lifetime.

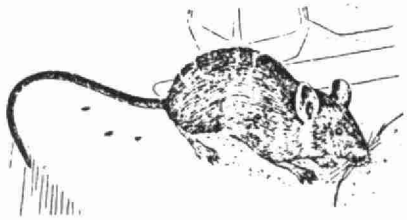
- The life expectancy is up to 1 year.

- Home range is usually within an area 100 to 200 feet in diameter.

- Roof rats are omnivorous but prefer vegetables, fruits, nuts, and cereal grains. They consume ½ to 1 ounce of dry food per day and drink about 1 ounce of water. Roof rats occur in almost all areas where Norways do.

- Roof rats prefer to live in grain mills, poultry houses, dense streamside growths of willows, wild grape and blackberry; older residential neighborhoods with dense growths of ivy, fruit, nut and palm trees; and in newer suburban developments set amidst former orchards. They are thought to enter sewers through sewer vent pipes and can infest sewers in the absence of Norway rats.

House Mouse (Mus musculus)



House mouse

- House mice resemble roof rats in miniature. They are agile climbers and are known to inhabit ground burrows in outdoor habitats.
- House mice have prominent ears, pointed muzzles, and slender bodies. The tail is unicolored, scantily-haired, and about as long as the head and body.
- Adults weigh ½ to 3/4 ounce and measure 2½ to 3½ inches head and body length. The tail measures 3 to 4 inches.
- The fur is brownish-gray to dusky-gray above and slightly lighter below.
- Droppings are small (1/8 to ¼ inch) and rod-shaped.
- Litter size averages 5 to 6 young.
- A female mouse may have as many as 6 litters in her lifetime.
- The life expectancy is up to 1 year.
- House mice are omnivorous but cereal grains are preferred. Mice require about 1/10 ounce of dry food per day and 3/10 ounce of water, but can subsist on as little as 3/100 of an ounce of water per day. They are nibblers rather than steady feeders.

EVIDENCE OF INFESTATION

Since rats and mice are habitually active at night and secretive, it is necessary to look for the characteristic signs they leave behind to determine if an infestation is present. Some of these signs are:

1. Droppings - Fresh droppings are shiny, moist, and soft; old droppings are dull, dry and hard.
2. Tracks - Look for a four-toed forefoot and a five-toed hind foot in dust or soil.
3. Burrows are most typical of Norway rats. Found outside buildings near foundations and in soil banks.
4. Gnawing to gain entrance to food and harborage and to keep growing incisor teeth worn down.
5. Live or dead rodents indicate either current or past infestation.

BIOLOGICAL FACTORS IMPORTANT IN RODENT CONTROL

Domestic rodents have a high reproductive potential because the females breed when quite young, can have several litters per year and have large litters.

1. Rats are capable of breeding at 3 months age and house mice at 2 months.

2. Breeding activity may be carried out any time of the year but is most concentrated in late spring and early fall.

3. Populations of rats reduced 90% by poisoning can return to their former level in 60 weeks in sewers, and 40 weeks above ground.

Movements of rats and mice tend to be quite limited.

Daily range of Norway rats in urban areas is only 100 to 150 feet in diameter. They rarely cross streets and are capable of living their entire life on a city block.

Roof rats may range over most of a city block and are known to cross streets on telephone or utility lines.

House mice have been found to inhabit an area only 10 to 30 feet in diameter and have been known to live their entire life within stacks of sacked goods.

Life expectancy of rats and mice is quite short.

Only 5% of Norway rats were found to live longer than a year. Life expectancy of house is probably only 6 to 9 months.

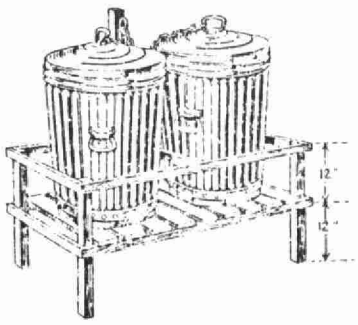
CONTROL OF DOMESTIC RODENTS

Successful domestic rodent control depends upon a balanced program of the following elements:

1) Environmental sanitation
2) Rodent stoppage and rodent proofing
3) Rodent suppression by:

    Poisons
    Traps

4) Continued surveillance and preventive maintenance



This program involves the basic approach to rodent control which is to reduce the capability of the environment to support rodent populations. Suppressive measures are considered as supplementary to this basic approach and not as a substitute.

1) Environmental sanitation

Rodent infestations in the urban environment generally are an indicator of an unhealthy environment.

- Poor sanitation means that food and harborage are usually abundant and easily available to rodents and as a consequence rodents become established in the environment. Poor sanitation is thus one of the basic sources for the continued existence of rodents in urban areas.

The orderly management and maintenance of the environment is known as environmental sanitation.

- Basically it consists of good housekeeping, proper storage and handling of food materials and organic wastes, and elimination of rodent harborage.

Sanitation of the premises is the responsibility of the owner or occupant of the property. The sanitarian and the pest control operator should make recommendations to the owner or occupant which will bring about environmental sanitation.

Garbage is a very important contributor to rodent infestations, providing an excellent source of food and water.

- Garbage should be stored in rodent-proof, covered containers of sufficient capacity to hold all garbage which accumulates between collections.

- Any rooms or shelters used expressly for the storage of garbage containers should be rodent proofed and cleanable.

- Racks or platforms on which garbage cans are stored should be so constructed that they can be easily cleaned and do not provide harborage for rodents.

- All refuse containing food particles should be stored in the same manner as garbage.

Stored foods in warehouses, commercial firms, or homes are especially vulnerable to attack by rodents.

- Bulk foods such as flour, sugar, dried vegetables, corn meal, rice, cereals, nuts, etc., should be stored in rodent-proof containers or rooms.

- Sacked foods should be stacked in orderly rows in a manner which will permit a thorough inspection of the area for evidence of rodent infestation.

  (1) Stacks should be on racks having 6 inches or more clearance above the floor.

  (2) Stacks should be at least 18 inches from building walls.

  (3) Stacks should not exceed 10 feet in width and aisles should be at least 18 inches wide.

  (4) A 6-inch wide white band can be painted at the base of the walls in order to more easily detect rodent evidence.

Materials stored indoors such as boxes, crates, sacked goods, machinery, etc., will create potential rodent harborage unless properly stacked on racks or shelves and should be inspected on a regular basis for rodent evidence.

All structural defects or dead areas, such as double floors, enclosed areas under cabinets, stairways and equipment, breaks in building structures, which contribute to rodent harborage, should be removed, modified or repaired.

Outdoor harborage may exist in improperly stacked lumber, boxes, bricks, machinery, etc. Racks with approximately 18-inch clearance above ground should be provided for such materials.

Other outdoor harborage in rubbish piles, weeds, brush, brambles, and junk should be eliminated.

Access to water should be prevented:

1) Leaky water outlets should be repaired.
2) Access to toilet bowls should be prevented by rodent proofing lavatories.
3) Drain or empty all sinks or sources of standing water every evening.

If conditions beyond the premises cause a constant reinfestation of the property under control, or make rodent

control impractical, they should be brought to the attention of the owner or occupant by the pest control operator and the local health agency should be notified.

2) Rodent exclusion by rodent stoppage and rodent proofing

Rodent stoppage is the structural modification of existing buildings to exclude rodents.

Rodent proofing is the design and construction of buildings so that rodents are prevented from entering and interior structural harborage is eliminated.

Limit rodent stoppage to the minimum necessary to produce the desired results.

As a guide to the nature and extentof work required, it has been shown that domestic rodents can do the following:

- Enter through openings larger than $\frac{1}{2}$ inch in diameter, and mice through $\frac{1}{4}$ inch diameter openings.
- Climb vines, shrubs, or trees adjacent to structures, or cross wires to upper stories.
- Climb vertical pipes up to 4 inches in diameter.
- Jump 36 inches vertically or 48 inches horizontally.
- Drop 50 feet without being killed.
- Burrow to a depth of 4 feet in soil.
- Emerge from floor drains, water trap or toilets.

All rodent stoppage work should be of a permanent nature and neat appearance.

Once rodent stoppage is done it only remains effective if intact. Repeated inspection and prompt repair is necessary to keep it intact.

An existing rodent infestation within a rodent-stopped structure should be eradicated.

A rodent-stopped structure should remain rodent free if:

- Rodent stoppage remains intact.
- Doors or windows are not left open.
- Rodents are not reintroduced with merchandise.
- No new structural openings are created.

3) Rodent suppression

1. Suppressive measure should be carried out where it is necessary to rid a premise of an existing rodent infestation and should be taken in conjunction with environmental sanitation and rodent exclusion measures. Suppressive measures are considered as supplementary to, and not a substitute for, basic environment sanitation.

2. Rodent suppression is accomplished by three general techniques:

   a) Trapping
   b) Fumigating
   c) Poisoning with baits or tracking dusts

a) Trapping

Trapping is the preferred method of killing rodents where:

- the use of rodenticides is to be completely avoided.
- the dead animals might die in inaccessible areas and cause an odour problem.
- the last few survivors of a poisoning refuse to take baits and must be cleaned out.

Kill traps such as the wood base snap traps are the most efficient.

Mice are easily trapped with snap traps; rats tend to be more wary of traps.

Traps for mouse control are set at frequent intervals of 3-4 feet against baseboards, boxes, platforms, etc. Mice have a very limited range of movement and traps must be numerous and close together to make certain they can be found.

Baits for house mice include rolled oats, peanut butter, gum drops, raisin bread, bacon, and nut meats.

Traps with baits for rat control should be placed near rat runs or where there is other sign of rats. Unbaited traps are set directly in runs, on rafters, pipes, or overhead cabinets so that rats will run through them.

Baits for rats include bacon, fish, ground meat, raisin bread, nut meats, prunes and apples.

Traps should be examined once daily and all captured rodents removed. Traps should be reset daily.

Handle all dead rodents with gloves or long forceps, or drop immediately into a plastic bag and secure the top. This is to avoid the hazard of bites from rat fleas or mites.

Incinerate or bury all dead rodents.

b) Fumigating

Fumigation is the killing of rodents with gasses. It is used to obtain a quick kill of rodents and their ectoparasites in inaccessible areas in buildings or burrows.

Fumigants can be quite dangerous to the person using them and a certain degree of experience or skill is required of persons engaged in rodent fumigation. In Ontario, only licenced pest control operators can do fumigation with prior approval from the Director of the Pesticides Control Branch.

The commonly used fumigants for rodent killing are calcium cyanide (Cyanogas).

Calcium cyanide is a powder which reacts with moisture to produce hydrocyanic acid. It is blown into the burrow with a special pump. The hose of the pump is inserted into the burrow opening and soil is packed around it. Then 5 or 6 strokes are made with the handle to blow dust into the burrow. Switch the valve to 'air' and with about 10 or more strokes blow the gas through the burrow system. Close the treated burrow with soil. If it is reopened in a day or two, it should be repeated.

Burrows that may lead under occupied buildings should not be treated with cyanide gas because this gas is lighter than air. Gas may enter the structure and produce hazards to the occupants.

c) Poison baiting is the most common and effective method used to suppress rodent populations

Poison baits can be either food or liquid baits.

Food baits consist of cereal grains, fish, meats, fruits or vegetables.

Liquid baits are used where the rodents' water supply can be controlled and are most effective in hot, dry areas.

Pre-baiting (offering plain bait for several nights before adding the poison) will increase the effectiveness of acute poisons.

Successful baiting depends upon a knowledge of rodent behaviour and acceptability of the bait materials.

Tracking dusts are a means of getting rodents to ingest poisons due to their habit of licking their feet and fur.

- They will ingest materials in this manner that they ordinarily would not eat in food baits.
- Tracking dusts can be used to check on the activity of rodents by noting footprints. Only non-toxic dusts, such as flour or talc, should be used in food areas or residences where children or pets might be exposed.

The poisons used in domestic rodent control are of two types: the slow acting or chronic poisons, like warfarin, and the fast acting or acute poisons, like strychnine. Each poison has its special characteristics, uses and hazards and these should be well understood. Not only can these poisons kill rodents but they are dangerous to man, pets, and domestic animals.

d) Anticoagulants

Warfarin, pival, fumarin and diphacinone are the safest poisons for general use and should be employed first. They must be eaten by rodents over a period of several days to be effective. They cause the animal's blood to lose its clotting ability and the animal bleeds to death from massive internal hemorrhages.

Anticoagulant baits exposed in bait containers for 10 to 20 days are replenished everyday or so. The bait take will generally be food for several days and then decrease as rats die off. Anticoagulant baits are most effective for Norway rats, less so with roof rats and house mice.

If anticoagulant baits are exposed in bait containers, the hazard to other animals is greatly reduced. Secondary poisoning of dogs and cats can be guarded against by picking up dead rats and mice.

e) Norbormide

Norbormide (trade name-Shoxin) is a specific poison that is used to kill Norway rats. All evidence to date indicates that most other warm-blooded animals are not affected by it.

Norbormide is an acute poison, killing Norway rats in 15 minutes to 1 hour after eaten. It causes a shock-like impairment of blood circulation.

Norbormide baits are small in quantity; usually a teaspoonful sized bait is enough to kill one Norway rat. Numerous baits are usually placed throughout the area where rats travel instead of in bait boxes.

Norbormide is effective against Norway rats, very erratic with roof rats and has no effect on house mice. There is no evidence that it harms dogs, cats or humans. It should not be used in any manner in which it might contaminate foods, however.

f) ANTU

ANTU is an abbreviation for alpha-naphthyl-thiourea. ANTU is a grayish-white fine powder,very effective against Norway rats but with little effect on roof rats or house mice. It is very little used today. It is mixed with regular food baits or can be used as a tracking powder containing 20% ANTU and 80% pyrophyllite.

ANTU may be exposed only in bait boxes in food establishments. Use of tracking dusts in food establishments is prohibited and they should be used only at floor level elsewhere. ANTU is very poisonous to dogs but this hazard is greatly reduced if baits are exposed in proper bait boxes.

g) Red Squill

Red squill is a bitter-tasting red powder prepared from dried bulbs of the squill plant. Red squill is effective in baits only against Norway rats. Used as a tracking powder it has been found effective against house mice.

Squill is a moderately slow-acting poison, causing death in rats by heart paralysis. Squill is a powerful emetic in most animals, but since rats cannot vomit baits once eaten, the material is particularly effective against them.

Used in food establishments, it should be confined to bait boxes at floor level. Used as a tracking powder in food establishments would be prohibited. Red squill powder is extremely irritating to the

nose and skin. A dust mask and rubber gloves should be worn during bait preparation.

h) Arsenic trioxide and sodium arsenite

Arsenic trioxide and sodium arsenite are moderately hazardous, rather slow-acting poisons. They are both highly toxic to rats, man, domestic animals and birds. Arsenic trioxide, used in food baits, is effective against Norway rats and roof rats, not against house mice. Solutions of sodium arsenite are used in poisoning house mice and rats.

Arsenic trioxide is tasteless to humans in baits. Arsenic is also absorbed through cuts or breaks in the skin and arsenic solutions can be absorbed through unbroken skin. Workers are advised to wear gloves when mixing or handling baits. It is recommended that arsenic baits only if exposed in suitable bait boxes.

i) Strychnine

Strychnine is effective only against house mice; rats quickly detect its presence because of its bitter taste and most will not eat enough to die. It is used on wheat, oat groats, and bird seed for house mouse control.

Strychnine is extremely fast acting--death can occur as soon as 12 minutes after eating. The combination of very rapid and violent death and very high toxicity makes this a very hazardous material. Strychnine baits should be exposed only in bait boxes to avoid exposure of children, pets and domestic animals.

j) Zinc phosphide

Zinc phosphide is a grayish-black powder with a definite garlic-like odor and strong taste. Most animals are repelled by this but rats apparently like the taste and smell. It is effective against all three domestic rodents.

Zinc phosphide is moderately fast acting. The powder releases phosphine gas when it contacts weak stomach acids. Both the powder and the gas are dangerous poisons. The poison should be weighed, mixed and handled only outdoors or in a well ventilated place. Rubber gloves should be worn when mixing and distributing baits. Do not heat or mix zinc phosphide with oxidizing materials.

4) Rodent Ectoparasite Control

Rodent ectoparasites should be controlled along with their hosts. Otherwise, if the rodent host is killed, the fleas and mites soon leave the dead body and the nest and will readily bite other animals and humans.

CHAPTER XI

STORED FOOD PESTS

INTRODUCTION

The climate in Ontario is ideal for many types of insects that are stored food pests. On the other hand, we also have many insects that are beneficial, in that they are parasitic and predaceous on the stored food pests. However, even if they are beneficial, when found in processed food, the food is then classified as adulterated.

Only the common major stored food insects will be covered in this syllabus. The major pests are in two groups: 1) beetles and 2) moths.

Common stored food product pests can be separated into groups according to the feeding habits of the larvae. The larvae usually do most of the damage, although the adult beetles also may damage their hosts.

Some larvae feed entirely within the kernels of grain and are called internal feeders. Examples are the rice and granary weevils and the grain moth.

Other larvae begin their attack on the grain on the outside and may end up eating the inside of the kernel. Such insects are called external feeders. Examples are: drugstore beetle, cigarette beetle, Indian meal moth, and the Mediterranean flour moth.

Scavengers feed upon grain only after the seed coat has been broken, either mechanically or by some other insect. Examples are the confused flour beetle, red flour beetle, and saw-toothed grain beetle.

RECOGNITION OF STORED FOOD PRODUCT PEST INFESTATIONS

Before any control can be attempted, the infested food sources must be located. Infestations of stored product pests may be recognized by the following:

1. Live or dead insects in foods or on shelves.
2. Webbing in food materials.
3. Insect droppings often noted in the bottom of a container.
4. Small holes in packages.
5. Insects flying about.
6. Damage to stored foods.

Look very carefully into all cracks and crevices where insects might be hiding and also inside containers of cereals, beans, peas, flour, dried fruits, dried pet foods, nuts and spices and any other stored foods that might support insect life.

INTERNAL FEEDERS

1. Granary Weevil (Sitophilus granarius)

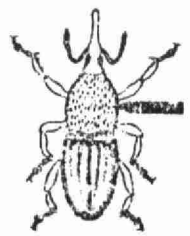
Recognition:

Adult - approximately 3/16 inch long, brown to brownish-black, long, slender snout. The back of the thorax is covered with elongated punctures.

Larva - approximately 1/8 inch long, white, footless, fleshy and thick bodied.

Life Cycle:

A female lays about 50 to 250 eggs. Larva burrows and lives inside host. It takes about 4 weeks from egg to adult under favorable conditions.



GRANARY WEEVIL

Hosts:

Barley, milo, oats, rice, rye, spinach seed, wheat and macaroni.

Remarks:

To distinguish this species from the rice weevil, note that the latter has hind wings (located under the hard wing covers) while the granary weevil lacks the hind wings. Also, the rice weevil has 4 light spots on back of hard wings which the granary weevil lacks.

2. Rice Weevil (Sitophilus oryzae)

Recognition:

Adult - approximately 1/8 inch long, reddish-brown to near black, long slender snout. The back of the thorax is covered with circular punctures.

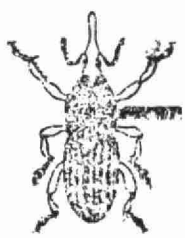
Larva - approximately 1/8 inch long, white, footless, fleshy and thick bodied.

Life Cycle:

A female lays about 300 to 400 eggs. Larva burrows and lives inside host. It takes about 4 weeks from egg to adult under favorable conditions.

Hosts:

Alfalfa seed, barley, buckwheat, chestnuts,



rice weevil

corn, maize, oats, rice, rye, vetch seed, wheat.

3. Angoumois Grain Moth (Sitotroga cerealella)

Recognition:

Adult - approximately $\frac{1}{2}$ inch wing expanse. Forewings yellowish-brown, hind wings notched at apical end.

Larva - approximately 3/16 inch long, white. Spends all of this stage in the host.

Life Cycle:

A female lays as many as 389 white eggs, which later turn reddish when mature. It may take as long as five weeks from egg to adult.

ANGOUMOIS GRAIN MOTH

Hosts:

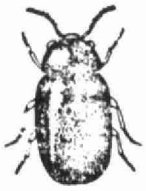
Infests grains and flour.

EXTERNAL FEEDERS

1. Cigarette Beetle (Lasioderma serricorne)

Recognition:

Adult - approximately 1/10 inch long; light brown color, oval shape, wing covers not striated, head hidden looking at it dorsally.



CIGARETTE BEETLE

Larva - Yellowish-white, curved (C-shaped) and many hairs, very slow mover.

Life Cycle:

A female lays 30 or more eggs. Larva forms a round ball-like cocoon when mature. It takes approximately 2 months for complete life cycle under favorable conditions.

Hosts:

Tobacco, milled cereals and other foods.

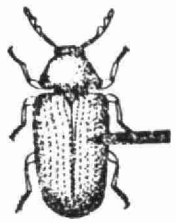
2. Drugstore Beetle (Stegobium paniceum)

Recognition:

Adult - approximately 1/10 inch long, oval shaped, uniform

light brown, wing covers striated.

Larva - very similar to cigarette beetle except it is less hairy.



DRUG STORE BEETLE

Life Cycle:

A female can lay several hundred eggs and the mature larvae builds a round ball-like cocoon. Life cycle about 2 months under favorable conditions.

Hosts:

Primarily found in flour, condiments, breakfast cereals, red pepper, paprika and many other foods.

3. Indian-Meal Moth (Plodia interpunctella)

Recognition:

Adult - approximately 5/8 inch wing expanse. Basal half of forewings grayish-white, posterior half reddish-brown, hind wings uniformly silver-gray. The moths are active in darkness.

INDIAN MEAL MOTH

Larva - approximately $\frac{1}{2}$ inch long, color varies from dirty white to pink, and occasionally with greenish tinge. Abdomen without dark brown spots from where hairs arise.

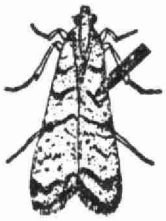
Life Cycle:

A female lays approximately 100 to 300 eggs. Egg to adult varies from about 4 to 44 weeks. Generations number from 4 to 5 in a single year. Larvae are very active and not only cause direct damage to hosts by feeding, but also by heavy webbing and deposition of excrement. Larvae of this species are commonly found in homes. Larvae have the habit of "wandering" when mature, and will be found crawling on walls and ceilings. In many cases, infestations in homes are on nuts (almonds, peanuts, walnuts).

Hosts:

Found in all kinds of grains, nuts, flour, dried fruits, chocolate bars and many other dried foodstuffs.

4. Mediterranean Flour Moth (Anagasta kuehniella)



MEDITERRANEAN FLOUR MOTH

Recognition:

Adult - approximately 7/8 inch wing expanse. Forewings mouse gray with a pair of dark zigzag lines. Usually these lines are removed from many specimens due to rubbing and activity of the moths. Moths are found hiding in dark areas.

Larva - approximately ½ inch long and white. Abdomen with dark brown spots from where hairs arise. Occasionally found in homes, but more often in flour mills. Besides direct damage by feeding, also damages hosts by heavy webbing and deposition of excrement.

Life Cycle:

A female is capable of laying from 100 to 650 eggs. It takes from 6 to 9 weeks from egg to adult. There are about 6 generations under favorable conditions.

Hosts:

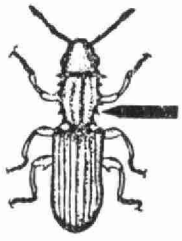
Primarily infesting flour, nuts and grains.

FLOUR BEETLES AND MOTHS

1. Saw-Toothed Grain Beetle (Oryzaephilus surinamensis)

Recognition:

Adult - approximately 1/10 inch long, flat, slender, brownish and active. Thorax (behind head where legs are attached) with six saw-toothed projections on back of each side.



Saw-Toothed Grain beetle

Larva - nearly 1/8 inch long, pale, yellowish color. Very active.

Life Cycle:

A female may lay from 45 to 285 white, elongate eggs. It takes 3 to 4 weeks from egg to adult under very favorable conditions. The number of generations varies from 4 to 5. The adults live on an average of 6 to 10 months, but some may live as long as 3 years.

Hosts:

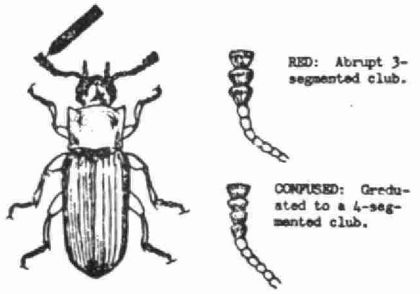
Found in packaged cereals, dried fruits, candy and flour.

2. Confused Flour Beetle (Tribolium confusum)

Recognition:

Adult - approximately 1/8 inch long, reddish-brown, wing covers with narrow longitudinal grooves.

Larva - about 3/16 inch long, white, tinged with yellow, elongated, cylindrical. On last posterior segment a pair of horns directed upward and backward.



CONFUSED AND RED FLOUR BEETLE

Life Cycle:

A female lays about 450 white or colorless oblong eggs. It takes about 6 weeks from egg to adult under favorable conditions. Average life of an adult is about 1 year, but some have lived longer than 3 years.

Hosts:

Breakfast foods, nuts, meals, grains and powdered milk.

3. Red Flour Beetle (Tribolium castaneum)

Recognition:

Adult - nearly similar to confused flour beetle.

Larva - nearly similar to confused flour beetle.

Life Cycle:

Nearly similar to confused flour beetle.

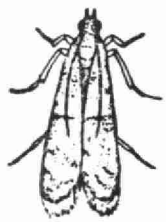
Hosts:

Grains, meals, flour, dried fruits and almonds.

4. Almond Moth (Cadra cautella)

Recognition:

Adult - approximately 5/8 inch wing expanse. Forewings brownish or blackish-gray and very similar to Mediterranean flour moth.



ALMOND MOTH

Larva - approximately ½ inch long, dirty white. Abdomen with dark brown spots from where hairs arise.

Life Cycle:

A female lays approximately 100 eggs. Eggs hatch in four to eight days during the summer. It takes about 6 weeks from egg to adult.

Hosts:

Occurs in candy, pet food, nuts and dried fruits.

CONTROL OF STORED FOOD PESTS

Sanitation:

The first step in control is to locate the source of the infestation. Many of the stored food insects are good fliers and the larvae may also move a considerable distance before being seen. They may occur in parts of the house quite removed from their actual source.

The infested source is usually confined to a small area, such as a closet or cabinet in the kitchen. Before any control is attempted, this source must be located. Look carefully into all stored food containers, including all boxes, sealed or not, cannisters and jars. Foods such as cereals, nuts, beans, peas, spices, dried fruits and flour, should be checked with care.

Remove all infested materials and destroy by burning or spray with a contact insecticide, such as pyrethrum, before disposing into the garbage can. If this cannot be done, place all infested items into a refrigerator freezer overnight before disposing.

Thoroughly clean all shelves and drawers in the infested area, paying particular attention to crevices. Use a vacuum cleaner to pick up food particles and dirt. Wash shelves with soap and hot water and allow to dry thoroughly.

Chemical Control:

General Equipment and Materials

Usual equipment used in stored food pest control are hand tank sprayers, foggers, misting devices, and air and power dusters (sometimes necessary to treat attic areas where products have been stored). Outdoor power spray equipment will be needed.

Materials that can be used are diazinon, chlordane, malathion, methoxychlor and pyrethrum.

Residential Infestations

The application of chemicals for the control of stored product pests in all situations requires considerable care on the part of the pest control operator. It is essential that insecticides, whether residuals or space sprays, be kept from direct contact with food products. No insecticide is to be considered as "non-toxic" or suitable for use directly on any food product.

Remove all foodstuffs from pantry area or other areas to be treated. Infested foods should be discarded, or heated to 140°F for ½ hour. A few of the items that stored food pests infest in the home are dog food, flour, cereal, dried foods, spices, nuts, candy and cakes.

After discarding infested materials, remove the contents of drawers and cupboards in the area and spray all shelves, drawer bottoms, cracks and crevices with any of the residual materials listed previously. Either emulsions or oil-base formulations can be used. After the chemical has dried, cover all drawer bottoms and shelves with paper to avoid having food or food containers come in contact with the residual. It may take several days for insects to contact the residual material and be killed. The housewife should be advised of this fact so that unnecessary call backs can be avoided.

Commercial Infestations

Warehouses have special sanitation and control problems. It is absolutely essential that the premises be cleaned of any loose food materials which may be lodged on the floor, the walls, or the ceiling, because this food will provide harborage for the insects even though the principal infestation may be removed. If the management of a warehouse will not clean up this debris, the pest control man should not enter into a control agreement with the company.

The pest control operator must first locate the particular material which is infested and identify the insects. Next the infested material must be removed from the premises. The insects cannot be killed inside the material without fumigation.

Markets

Prompt removal of infested material and cleaning up of infested debris is the first step in the treatment.

Follow this with a thorough application of a contact insecticide to kill exposed adults and larvae. Insecticides can be applied by mist blowers or foggers and followed by hand application of residual insecticides. Be sure to cover all items not in tight containers with a plastic sheet before spraying.

Food Stores

Use only a contact space spray containing pyrethrins in food stores. Apply the material by fogging or misting devices only. This will prevent wetting of any packaged goods. Good sanitation should be followed by removing any infested materials and disposing of as mentioned above.

It may be necessary to spray the structure exterior where waste food products are spilled outside or accumulated by being swept or drifting. If possible, try to have such areas cleaned. Outside waste food accumulations can be an important source of reinfestation and should not be overlooked.

CHAPTER XII

TICKS

RECOGNITION

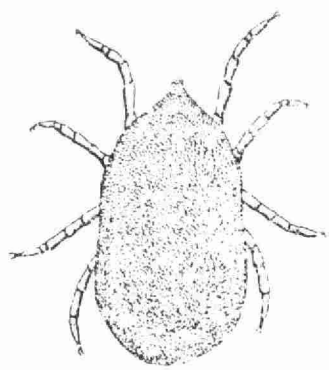
Ticks are leathery-bodied, 8-legged arthropods belonging to the Order Acarina. All ticks have mouthparts designed to penetrate and hold fast in the skin of vertebrate animals and to withdraw blood.

Ticks are divided into two main groups: hard ticks (family Ixodidae) and soft ticks (family Argasidae). Hard ticks have a hard shield on the dorsum or back which covers the front 1/3 or so of unfed females and the entire back of males and nymphs. Soft ticks have no shield. Instead, the entire integument or 'skin' is leathery and often characteristically bumpy or granular in appearance. Males and females of soft ticks are similar. Both the hard tick and soft tick groups have representatives throughout the world from tropic to arctic regions.

Another important difference between hard ticks and soft ticks is that the latter invariably are associated with the nest or dwelling place of the host animals they live on. Some hard ticks also dwell in nests, but most of those important to man are found outside nests and dwelling places. When ready to feed, they wait on tips of vegetation for a passing host. Hard ticks feed only 3 times, once in each stage and each time to engorgement, and grow to many times their original size. People are bitten by adult hard ticks, rarely nymphs. Soft ticks feed several times in the nymphal and adult stages. They fill out after a blood meal but expand only 2 or 3 times the original size. Both adults and nymphs will bite man.

SOFT TICKS

The soft ticks, Ornithodoros hermsi, O. turicata, and O. parkeri are vectors of relapsing fever. O. hermsi is of particular importance in mountain areas of western provinces where it lives in nests of chipmunks and pack rats. When chipmunks build nests in cabins or outbuildings, ticks are introduced. If the chipmunk dies or leaves, hungry ticks leave the nest in search of a blood meal and will bite man quite readily. Some tick-infested cabins have been known to produce several relapsing fever cases over a period of years. These ticks are active in spring and summer. Not common in Ontario.



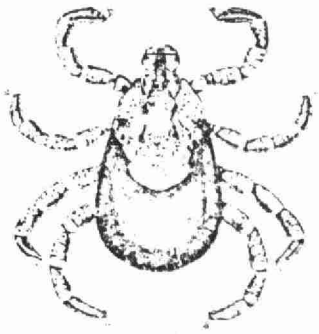
Soft tick

The pajaroello tick (Ornithodoros coriaceus) is a vicious biter and may cause severe, long-lasting reactions in persons sensitive to its saliva. It is associated with larger animals and is usually encountered on hillsides frequented by deer.

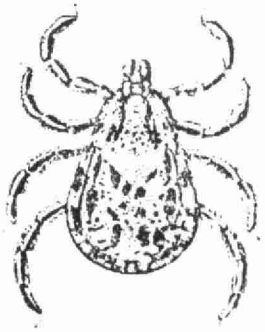
The fowl tick (Argas persicus) is a soft-bodied tick, flat, with thin edges, usually oval shaped, that lives in poultry houses or roosts where it hides in cracks and crevices. The tick is damaging to poultry and occasionally may inflict painful bites on people, especially when fowls roost near human habitation.

HARD TICKS

The Rocky Mountain wood tick (Dermacentor andersoni) lives in the rocky mountains. It is capable of transmitting Rocky Mountain spotted fever, tularemia, and Colorado tick fever. Ticks that attach around the head or neck can cause tick-bite paralysis, a condition that is remedied when the tick is removed. Adult ticks are most numerous in spring and early summer. This species has habits similar to D. variabilis, with which it is almost identical in superficial appearance. It is an important pest of cattle, horses and dogs.

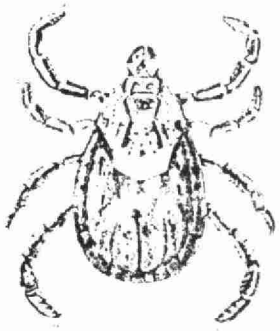


Female



Male

The American dog tick (Dermacentor variabilis)occurs from the Atlantic Seaboard west through the prairie provinces. It also transmits Rocky Mountain spotted fever and tularemia and readily bites man. It is a severe pest on dogs and may be brought into contact with man by means of his pets. It also is most numerous in spring and early summer.

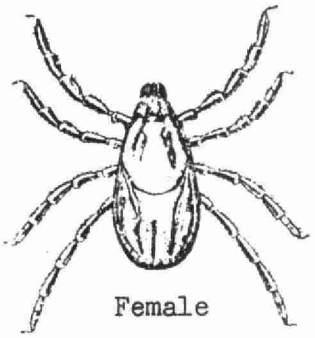


Female

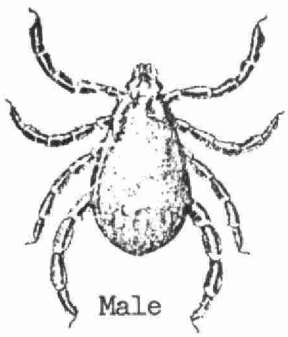
Male

Ixodes pacificus (no common name) occurs in coastal and mountain areas and is most abundant in cooler, moister places. It is a smaller, darker tick than the other hard ticks discussed, but has longer mouthparts. It is a vicious biter and has a tendency to 'burrow in', making it difficult to remove. Its bite is often intensely painful and may cause a severe reaction in sensitized persons. Adults appear after fall rains and persist through spring.

The brown dog tick (Rhipicephalus sanguineus) is associated with domestic dogs, their kennels, runs, and houses. When ticks are not on a dog, they hide in cracks and crevices, often in great numbers. However, houses with brown dog tick infestations may become overrun with them.



Female



Male

- The brown dog tick is a hard tick that spends all its life cycle in and near the living quarters of its host. Engorged females drop off and crawl into cracks and crevices to lay eggs. Larvae and nymphs also hide in such places and come out only when ready to feed.

Dog kennels, runs, and houses may shelter hundreds of hiding ticks.

- Adult males are reddish-brown, 1/12 to 1/8 inch long. Adult unengorged females resemble males. Engorged adult females may be $\frac{1}{4}$ to 3/8 inch long. Females have grey-blue to olive bodies. The nymphs resemble adult females, but are smaller.

  The larvae resemble small nymphs, but have six legs. The eggs, laid in groups of thousands, show a whitish spot just before hatching, but are smooth, shiny dark brown, otherwise. After laying eggs, the shriveled female dies.

- Under ideal conditions the life cycle may be completed in about two months, however, under normal conditions, with a host present, there are usually 3 to 4 generations per year. Because larval and nymphal stages can live two months, without feeding, and adults can live at least eight months with no host, infestations can persist long after dogs leave the premises.

LIFE CYCLE AND HABITS

Soft ticks pass through 5 stages: egg, larva, 1st nymph, 2nd nymph, and adult. Eggs are laid over a period of time and in batches in the nest or living quarters of the host. The 6-legged larvae hatch and usually feed for several days, but larvae of some species do not feed at all. Larvae molt into the 8-legged 1st nymph. The 1st and 2nd nymphs and adults do not attach to the host. Instead each stage takes several blood meals before molting. Soft ticks feed rapidly, from a few minutes to a few hours, and then drop from the host. Females must have a blood meal to develop each batch of eggs. The ticks are not often found on the host, but in its nest, burrow, bed, or roost. Soft ticks may survive months or years without feeding.

Hard ticks pass through only 4 stages: egg, larva, nymph, and adult. All eggs are laid in one large mass of 1,000 or more. The 6-legged larvae hatch and must find a small animal for a host. They take one large blood meal and molt into an 8-legged nymph. The nymph also must find a host, feed to engorgement, and molt into an adult. A 3rd blood meal is necessary for reproduction. This process usually requires 1 year but may require 2 or even 3. Hard ticks usually attach firmly to the host and may feed from several hours to several days before dropping from the host.

Dermacentor andersoni, D. occidentalis, D. variabilis and Ixodes pacificus are found where there are rodents as hosts of the larvae and nymphs and larger animals as hosts for the adult ticks. Adults of D. variabilis prefer dogs, foxes, coyotes and bobcats. Each of these ticks seeks a host by climbing to the tips of vegetation and waiting for hosts to brush by. Persons passing by pick up adult ticks waiting for large animal hosts.

Most complaints result from: 1) detection of ticks on persons, animals, or premises, 2) tick bite and tick paralysis, or 3) a case of tick-borne disease, such as relapsing fever, Colorado tick fever, or Rocky Mountain spotted fever.

CONTROL OF TICKS

Control measures against ticks depend upon: 1) the kind of ticks involved 2) the location of the infestation, and 3) the kinds of hosts involved, if any.

Control measures consist of: 1) changing the environment to reduce or eliminate ticks or their hosts, and 2) chemical control methods.

Infestations of soft ticks (Ornithodoros hermsi) in mountain houses, cabins and outbuildings require both chemical and environmental control measures:

1) Insides of buildings should be treated around baseboards, moldings and other possible entry points for ticks. Attics, areas underneath floors, and accessible areas between walls also should be treated.

2) Following chemical control measures, houses or cabins should be effectively rodent proofed to eliminate further infestations. Nesting places, e.g., accumulations of junks, wood, etc., in outbuildings should be eliminated wherever possible.

3) In the immediate vicinity of houses or cabins, natural nesting places for rodents should be eliminated. In particular, snags, stumps, old logs and piles of debris should be removed. Wood piles should be tiered.

Soft ticks on burrowing rodents

Control of soft ticks (Ornithodoros parkeri and O. Turicata) associated with burrowing rodents seldom is necessary in Ontario. Soft ticks in burrows may be controlled by burrow dusting as for fleas, followed by rodent control.

Ornithodoros coriaceus (pajaroello tick)

There are no control measures specifically designed for these ticks. Persons are best protected from them by avoidance. In places of high public use, treatments aimed at hard ticks also should control pajaroello ticks.

Hard Ticks

1) Hard ticks in yards and places of heavy human use are controlled by area treatment.

2) Thorough coverage is important.

3) In treating areas where there are streams or ponds containing fish only selective chemical should be used.

4) In larger areas, treatment of vegetation on both sides of trails, pathways, and roads offers protection from ticks. A swath of 4 feet or more is sprayed or dusted so as to obtain full coverage of vegetation as in area treatment.

Brown dog ticks are controlled by insecticides applied in dog quarters and other infested areas.

1) Brown dog ticks are difficult to control, especially where the infestation is widespread and heavy. Their habit of hiding in cracks and crevices makes the ticks hard to reach with insecticides and also makes desirable the use of materials with residual effect.

2) Fenthion (Baytex) (3% oil solution), malathion (1% oil solution), and diazinon (0.5% emulsion) are effective against brown dog ticks. Ronnel (Korlan) (1.0% spray), and carbaryl (Sevin) (5.0% spray) are accepted for control of brown dog ticks. Where there is no resistance to chlorinated hydrocarbons, chlordane (3%), or lindane (0.5%) may be used. Diazinon (0.5% oil base) plus DDVP (0.5% oil base) with a trace of pyrethrum as an activator and 90% isopropyl alcohol for rapid drying has been very effective. It may be used inside only if premises can be vacated for twenty-four hours and aired before reoccupancy.

3) In treating homes, malathion (1-2%), chlordane (5%), and ronnel (Korlan) (2%), may be sprayed. All other insecticides recommended should be applied as spot treatments.

4) Silica aerogel, effective as long as it is dry, may be placed in cracks and crevices to kill hiding ticks. Confine material to hiding places of ticks, as some animals react adversely.

5) In treating an infestation, special attention should be given to baseboards, floor and wall crevices, window frames, and other harborage sites. Thoroughness is important. Engorged brown dog ticks tend to move upward, therefore ceiling moldings, if present, should be treated and picture frames inspected.

6) Dog beds and bedding should be cleaned up, treated, and bedding laundered or burned.

7) All animals should be treated by a qualified practitioner of veterinary medicine.

CHAPTER XIII

PESTICIDAL EQUIPMENT

INTRODUCTION

A. It is of extreme importance that pest control operators have a basic understanding of the function and maintenance of each piece of equipment with which they work. Only effectively designed and properly maintained equipment can convey a pesticide to a pest in a safe and efficient manner.

B. Proper application of pesticides return extra profits by avoiding costly repairs, increased maintenance, use of excess chemicals and damage to household furnishings and buildings.

C. Pesticides may be applied as solids, liquids or gases. Solids are usually applied as dusts or distributed as poison baits. Liquids are applied as residual sprays, mists or fogs. Application of poisonous gases requires a knowledge of fumigation techniques which, for the most part, are not within the scope of this text.

TYPES OF EQUIPMENT

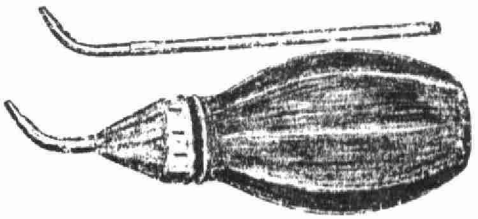
A. Dusters

Dusts are usually used in preference to liquids wherever they can be thoroughly and safely applied, and where the presence of the dust itself is not an inconvenience. Dust is effective when wall voids have to be treated from small openings. It is safe around electrical connections which could be short circuited by water base insecticides.

1. Hand Operated Dusters

a. Getz, or bellows type. A squeeze type powder blower, consisting of a rubber cylinder about 5" tall, held upright by a coil spring. The metal top has an opening through which dust is introduced; the metal bottom has a tube through which dust is blown out. Capacity: 4 to 8 ounces.

b. Centrobulb, or flexible bulb type. A rubber bulb fitted with a screw cup and nozzle, with nozzle extensions available. Capacity: 4 to 14 ounces.



These dusters (a and b) are very practical for light, indoor jobs requiring careful placement of dusts in small cracks, openings and wall voids.

c. Rotary type, hand crank dusters. A hand crank operated fan blows dust through a long tube available with adjustable nozzles. Capacity: 2/3 to 14 pounds.

d. Hand plunger dusters. An air blast is forced into the dust reservoir by a plunger, dispensing dust in a fine cloud. Capacity: $\frac{1}{4}$ to several pounds.

These dusters (c and d) are designed to disperse dusts into large areas, crawl spaces, attics, etc.

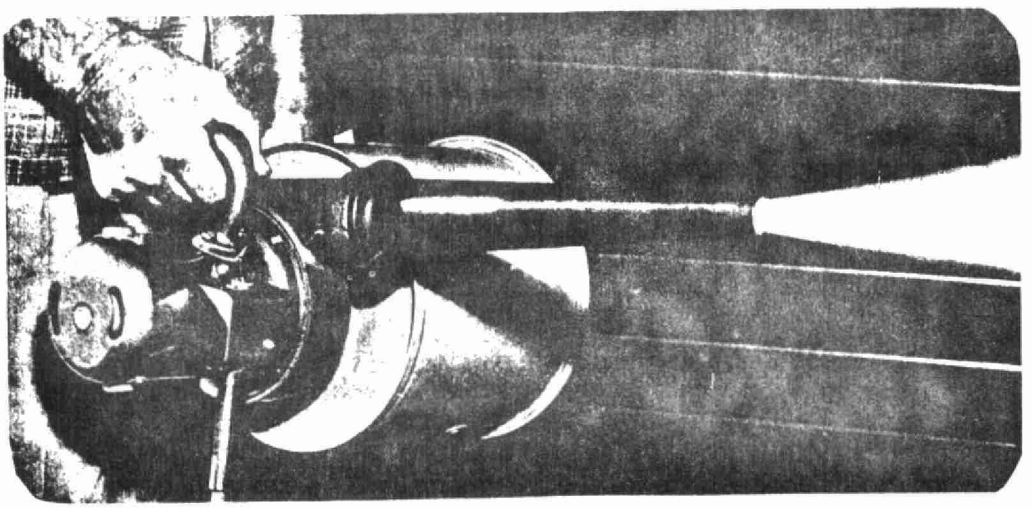
e. Foot pump dusters. A plunger type blower designed for rodent burrows. The pump is held down by foot, using a stirrup, and the hand operated plunger blows dust into burrows through a flexible hose. Capacity: 1 and 5 pounds.

After dusting operation is over, make sure that all dust is blown from the outlet before withdrawing tube from the treatment area to prevent accidental dusting of places not under treatment, and operator.

f. Maintenance of hand operated dusters. Nozzles should be cleaned periodically since dust cakes up due to moisture. Dusters with rubber bodies should be checked for cracks and deterioration. Gears of rotary dusters must be well lubricated. Cup leathers of plunger types should be lubricated with graphite powder and light oil in accordance with manufacturer's directions.

2. Power Dusters

a. Several types of power dusters are available, powered by gasoline or electricity, usually consisting of motor, dust hopper and a radial fan. They are designed to produce fine and uniform layers of dust where deep penetration of large areas is required.



Power duster, operated by electricity

b. Two and one-half gallon air pressurized fire extinguishers modified into power dusters are now used by pest control firms. The compressed air forces dust out in a fine cloud and deposits it in uniform layers. Compressed nitrogen may be used instead of compressed air.

c. Maintenance of power dusters. Gears, motors and other parts of power equipment must be well lubricated, and otherwise maintained in accordance with manufacturers' instructions. As with hand dusters, power equipment must be cleaned regularly to keep it free of caked dusts. Most insecticidal dusts are hydroscopic (attract moisture). When in storage, hoppers should be emptied.

B. Bait Containers and Other Bait Devices

Insecticides and rodenticides may be mixed with solid foods, as liquids, granules, pellets, or in pastes. The type of bait and the area in which it will be used must be carefully considered. If other acceptable foods are available to pests, baits may prove ineffective. Care should be taken to keep baits out of reach of pets and children. All bait containers must be marked "Poison", and have the firm name and emergency telephone number marked on them. After the baiting program is over, temporary bait containers should be burned or buried.

1. Paste forms of bait are squeezed out of tubes into small containers and placed where pests breed and hide.

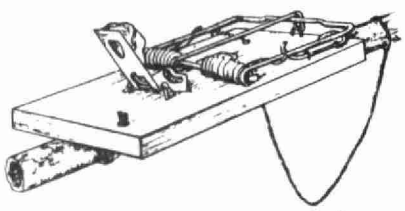
2. Granular baits for outdoor use may need no container and may be spread by hand or by hand cranked seed spreaders.

3. Baits in pellet form can be placed in small souffle cups if they can be placed out of reach of pets and children.

4. Anticoagulant baits for rodents are dispensed in a variety of containers ranging from a simple tray, with or without a separate compartment for liquid baits, to more complicated bait boxes. Trays should be made of materials that will not mold, mildew or deteriorate, and should be tip-proof to prevent spillage. Bait boxes may be of wood, metal, or disposable paraffin coated cardboard. They have openings on both sides, about 2 inches in diameter, and partitions for liquid and solid baits. Some have hopper so that bait falls into the feeding chamber according to the amount consumed.

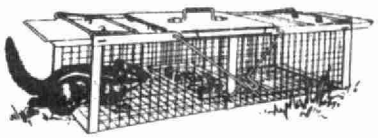
C. Traps

1. Snap traps, with wooden bases and spring operated jaws designed to kill rodents immediately, are most commonly used.



Spring trap

2. Live animal traps are designed to capture animals unharmed for later disposal.



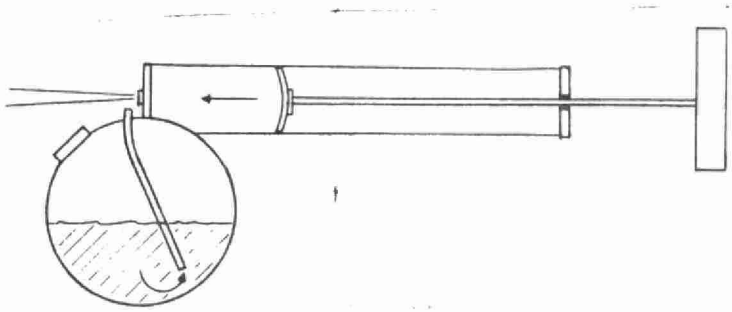
3. Dozens of other trap designs are available and may be utilized depending upon the conditions that exist.

4. All traps should be steam cleaned periodically.

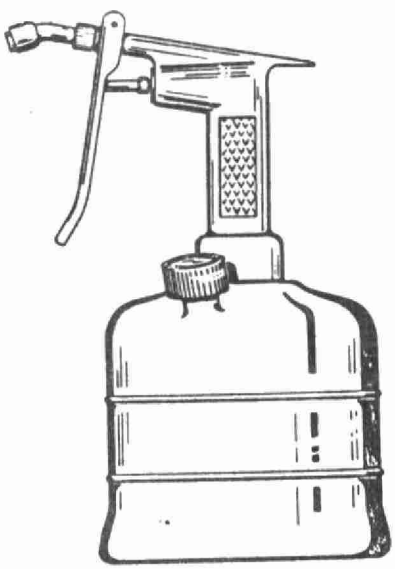
D. Residual Sprayers

1. Hand Operated Sprayers

a. For localized or spot treatments, small hand operated hydraulic pump sprayers are often used. The insecticide is forced out through a nozzle when the plunger is activated, or may be pulled out of a siphon tube when a column of air is driven past the opening. The pressure sprayers are usually provided with two nozzles, to produce either a straight stream or a mist. Capacity: 1 pint to 1 quart.



Hand operated sprayer. Liquid is pulled upward through a siphon tube and blown into a mist.



Hand operated sprayer. Hydraulic pressure created by squeezing lever forces liquid out through nozzle.

b. The generally used compressed air sprayer, capacity ½ to 4 gallons, has a tank preferably of stainless steel, a pump to compress air, a discharge tube with 4 or 5 feet of hose and a spray wand with an adjustable nozzle.

(1) The tank should be filled to about 3/4 of its volume with the required insecticide. When the plunger of the pump is operated, air is forced through a check valve at the bottom of the tank and rises up into the air space at the top of the tank. The air is now compressed and exerts pressure upon the insecticide. When the valve situated on the spray wand is opened, compressed air forces liquid through the delivery outlet, tube, hose and nozzle.

(2) Air should be first compressed to about 50 pounds. Spraying may begin and continue until the air pressure drops to about 30 pounds. It should then be pumped back to approximately 50 pounds, having an average pressure of about forty pounds during spraying to assure uniform flow rates, patterns and spray characteristics for which most nozzles are designed.

c. Nozzles should be selected to give the spray pattern desired.

(1) A pin stream nozzle is specifically used to penetrate insecticides deep into cracks and small openings.

(2) The fan, or flat spray nozzle, produces a fan-shaped pattern and is used when an even coating of insecticide over a flat surface is desired.

(3) Solid and hollow cone nozzles produce round patterns, and also cover surfaces evenly.

(4) Nozzles are available which can be adjusted to produce various spray patterns.

d. Maintenance of hand operated sprayers. Sprayers in regular use should be washed thoroughly once a week with detergent and water. All parts should be flushed out and water run through the sprayer until it appears clear. The following items should be considered in maintaining hand operated sprayers:

(1) Keep tank free of rust, scale and dirt, which will impair pumps and nozzles, and clog strainers, preventing the proper flow of insecticide through the system.

(2) After cleaning and flushing, dry sprayer thoroughly before filling with an oil base insecticide.

(3) Release pressure from sprayer when not in use. Pressure may cause bottom of tank to bulge out, or rupture deteriorated hose. Use air release valve, or if tank has none, turn tank upside down and release pressure through spray gun.

(4) Regularly inspect hose, especially at points of attachment near tank and spray wand to prevent accidental bursting.

(5) Lubricate leather plunger (piston cup) every two or three weeks with Neatsfoot oil to retain shape and lessen effort required for pumping.

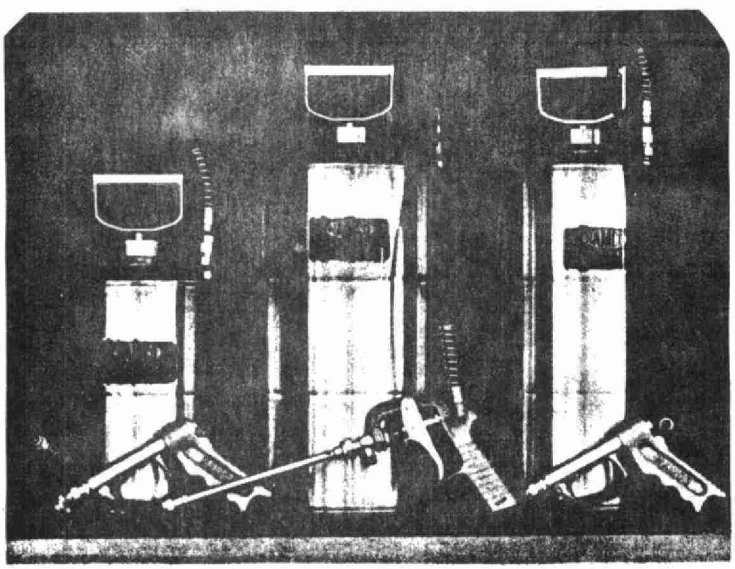
(6) Keep bottom of pump cylinder free of dirt and solid material to avoid check valve leakage problems.

(7) Clean strainer screen once a week to prevent buildup of trapped materials.

(8) Watch carefully for leaky shutoff valves at all times to prevent staining of carpets and other articles, the contamination of food, or the dripping of insecticide onto the hands or clothing of the operator. Replace packing gaskets or valves when necessary.

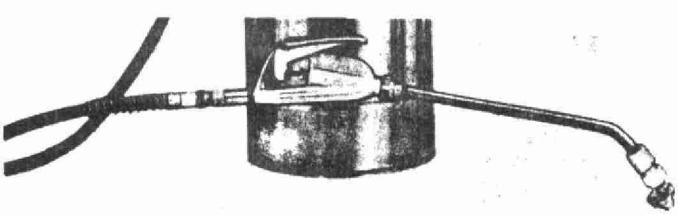
(9) Watch amount of flow and uniformity of insecticide application. If nozzle opening gets clogged, clean with blast of air or soak in solvent and use small brush (<u>not</u> with metal bristles) to remove particles. Do not insert needles or other hard materials into the small orifice of nozzles. Such things may break, or distort the nozzle openings and give uncontrolled flow of insecticide.

(10) When storing sprayers for long periods, release pressure. Empty and clean tank and all other parts to prevent corrosive action. Store the sprayer with the spray wand and hose in a vertical position that will prevent sharp kinks in the hose.

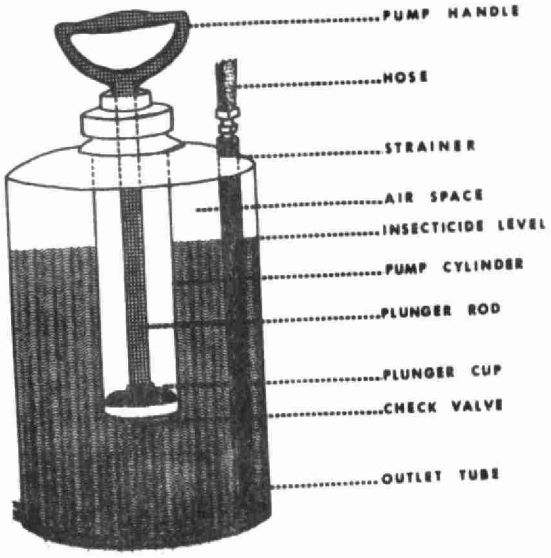


<u>Hand pumped compressed air sprayers</u>.

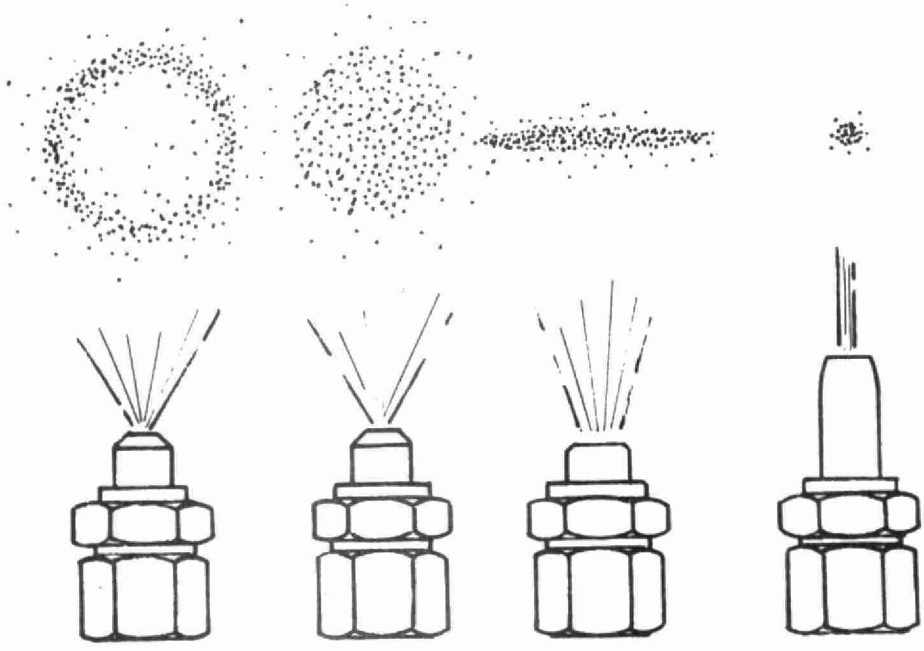
Pistol grip nozzles and straight spray wand.



Curved spray wand.



Hand pumped compressed air sprayers, diagrammatic.



Diagrammatic presentation of nozzles and spray patterns.
Left to right: hollow cone, solid cone, flat fan, pin stream

2. Power Operated Compressed Air Sprayers

Compressed air sprayers powered by gasoline or electrically driven compressors work on principles similar to those of hand operated sprayers. Their capacity ranges from 10 to 100 gallons or more. They require heavily constructed tanks and are seldom used by pest control operators.

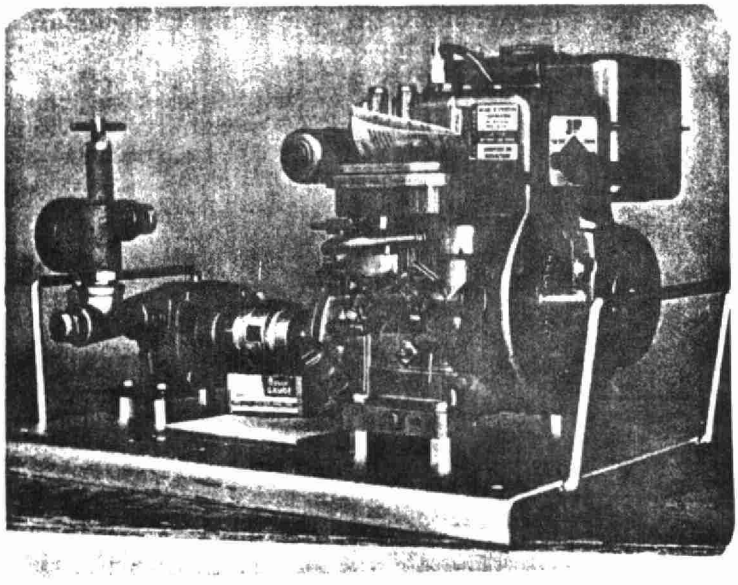
3. Hydraulic Power Sprayers

These sprayers are powered by gasoline or electrically driven pumps. The pumps pressurize the insecticide and force it through the system instead of compressing air.

a. Pumps are extremely important parts of sprayer systems, since they must deliver specified volumes at uniform pressure to assure accurate applications. They must be drained of insecticide when in storage. Pumps may be either the rotary type (roller, gear or impeller pumps) or the reciprocating type (piston, plunger, or diaphram pumps).

(1) Piston pumps are capable of discharging 30 to 40 gallons of insecticide per minute at pressures up to 500 to 800 pounds per square inch. The surging action causes movement of the hoses and may damage them if they are in contact with abrasive surfaces.

(2) Skid mounted, gasoline driven roller type pumps are widely used in the pest control industry. They are capable of discharging 2 to 25 gallons of insecticide per minute and pressures up to 350 pounds per square inch. Rotary pumps have less surging action than piston pumps, thus the hose has less chance of damage.



Portable, gasoline driven,
rotary pump

b. Pressure regulators are installed on hydraulic sprayers to maintain desired pressures. These consist of large steel ballbearings forced against valve seats by springs. Screws, nuts or levers are provided to adjust spring tensions for high or low pressure. When pressures exceed the amounts adjusted for, excess spray recirculates through the pumps, or returns to the spray tank. This action brings about agitation in the tanks and helps to keep formulations uniformly mixed. Mechanical paddles or propeller type agitators are desirable when wettable powders are used.

c. Spray tanks on power sprayers range in capacity from 50 to 600 gallons, seldom exceed the 150 gallon size when used in public health vector control operations. Thirty to fifty gallon tank sizes are widely used in pest control operations. Tanks of this size should be made of corrosion resistant material, or be lined with a corrosion resistant liner. Fiberglass tanks are available that do not rust, rot or react with chemicals. Spray tanks must be kept clean, free of dirt, rust, scale or other foreign matter.

d. Hoses are made of several different synthetic rubbers which are suited to withstand the required amount of pressure, and do not leave ugly rub marks against objects. For power sprayers operated by the general pest control operators, a hose with an inside diameter of 3/8" to ½" should be sufficient. Hoses should be inspected regularly for excessive wear, cracks, or breaks, especially near the points of attachment. They should also be tightened just enough at the junctions to prevent leakage. This precaution could avoid an accidental bursting of the hose while the power sprayer is in action. Hoses should also be flushed thoroughly with detergent and water.

e. Screens, used to prevent foreign particles from entering the sprayer system, protect precision parts. Suction strainers, line strainers, and nozzles should be provided with screens of the proper mesh size. Any sediment or residue allowed to build up in the screens, would restrict the proper rate of insecticide flow resulting in an uneven application, so screens should be kept clean at all times and regularly checked for breaks.

f. Valves function by turning on or stopping the flow of insecticides. Most sprayers are now equipped with fast acting valves that are situated at the nozzle tip, preventing any drippage. Leaky, shut-off valves could result in staining or contamination or insecticide dripping onto the hands or clothes of the operator and should be repaired or replaced.

g. Nozzles must be kept clean so that they are able to discharge a controlled and uniform rate of material within a required pressure range. Nozzle tips made of hard metals may be costly, but

they last longer. A proper selection of the nozzles to give the desired spray delivery patterns should be considered.

A blast of compressed air, or soaking nozzles in solvent and cleaning with a toothbrush or small bottle brush will open clogged nozzle tips. Pins, needles, or pieces of wire must not be used to free solid particles.

h. For long-term storage, equipment must be kept dry and all moving parts oiled to prevent corrosion.

i. If using a brand new sprayer, clean out all loose metal chips or other particles, then thoroughly flush the tank, pumps, and lines with water. Remove nozzles to flush the system.

j. In preparing to spray, the spray applicator should be cleaned and checked thoroughly well in advance to see if it is properly equipped for the job and to avoid unnecessary delays. If using emulsions or wettable powders, clean water must always be used, because particles of sand or mud in the water could cause excessive damage or wear to the pumps, valves and nozzles. The chemicals should be added when the spray tank is partially filled with water.

4. Space Sprayers

Because of the difficulty in drawing a fine line between mists and fogs, (= aerosols), there is overlap in terminology when describing mist and fog applicators. Some pieces of this equipment are known as "foggers", and others are called "mist blowers". Mists and fogs are used as space sprays with contact insecticides for killing flying or crawling insects. They offer very little, or no residual effectiveness.

Mists are composed of very minute droplets which even under unfavorable thermal currents will settle down to the ground. According to Glasgow (1947), the average diameter of a droplet in a mist is roughly about 40 microns (1 micron is approximately 1/25,000 of an inch). A fog is composed of uniformly smaller droplets than a mist. The fog remains suspended in the air for a much longer period, moving only on available air currents and will settle only in relatively still air. The particle size of a fog is roughly 4 microns in diameter.

Mist and fog applicators are capable of dispensing low volumes of concentrated insecticides into large areas and they require low manpower for insecticide applications over a large area in short periods of time.

Because neither mists or fogs can be directed indoors with a high degree of accurary, the areas to be treated and the insecticide selected, must be thoroughly considered for safe application. If a thermal fog generator is used, oil solutions should be used because

the fog produced will have much finer particles; whereas the water emulsions emit a much coarser droplet size. Also, some decomposition of the insecticide may result in a thermal fogger, due to the heat produced. The use of high flash point oils, such as No. 2 oil, will reduce the rate of decomposition to a certain degree, and also minimize explosion hazards. Before a fogging or misting operation, make sure that all open flames, such as pilot lights, are extinguished. This precaution is necessary because fogs and mists can build up explosive concentrations of fine droplets in confined air spaces. Care should also be taken not to turn the electric switches on and off, as they could sometimes cause sparks. Carbon formation within the thermal foggers and the tank intake hose of other foggers and mist blowers must be cleaned regularly.

a. Mechanical Aerosol Generators (mist applicators)

(1) These machines are capable of producing a relatively wet, low micron size mist. Some mist applicators operate on the same principles as compressed air sprayers. They disperse a small amount of insecticide at a relatively high pressure through a minute opening in the nozzle. Compressed air in other mist blowers, drives the insecticide through a discharge tube directly into the path of an air blast; atomization occurs at this point, breaking up the insecticide into fine droplets.

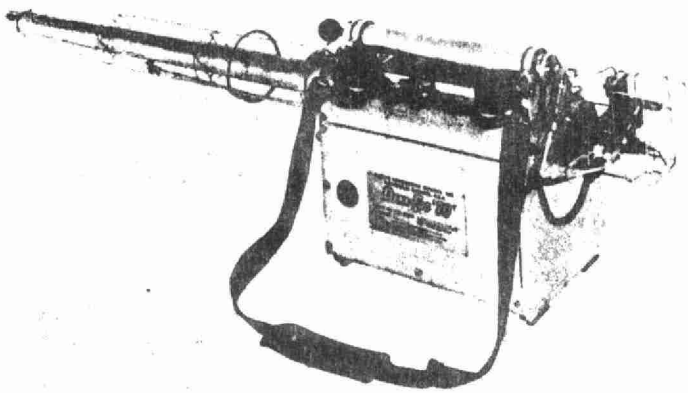
(2) Small, portable electrically operated mechanical aerosol generators are commonly used by general pest control operators.

A small electric motor operates a diaphram-type compressor, or high speed revolving disks. The revolving disks, mounted on a drive shaft, eject a thin film of insecticide by centrifugal force. A blower on the drive shaft shears off the insecticide into fine droplets and blows them out at a high velocity.

Electric aerosol generator

b. Thermal Aerosol Generators (fog applicators)

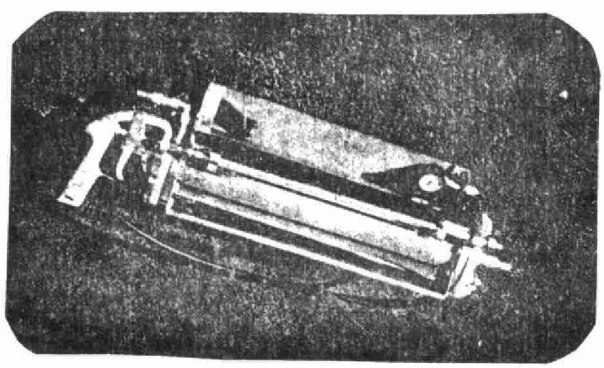
These applicators produce a relatively dry type fog by breaking up or vaporizing the insecticide with hot gases or superheated steam. Only low volumes of relatively concentrated contact insecticides are used in foggers, compared to the residual insecticides used in the other applicators. Oil solutions must be used in the thermal fog generators because water emulsions do not produce a dry type fog with fine particles. Heat is generated within the heat chamber by an electric motor, gasoline engine or by steam velocity ejection. Vaporization of the oil base formulation occurs when the temperature within the heated chamber reaches a certain degree. Generally, larger fogging units use the exhaust of an internal combustion engine. The range in the volume of fog disseminated is from $2\frac{1}{2}$ to 60 gallons per hour.



Thermal fog generator

c. Compressed Gas Generator

The "hi-Fog" machine is a special type of portable applicator. It is "airless" because it operates on compressed gas under very high pressure (300 to 1000 psi). When an insecticide is pumped into a hollow cylinder it develops its own pressure by forcing a piston back against a nitrogen gas charge, which acts as a spring to force the insecticide out through a very minute orifice in the nozzle. No air is mixed, and the insecticide is homogenized under tremendous pressure, dispensing micron-size droplets uniformly at very low volumes. The spray nozzle is adjustable from a fine fog to a straight stream, hence it can be used for fogging, misting and residual applications. The insecticide may be pumped into the cylinder by a hand pump or power operated loaders.



Compressed gas generator

d. General Maintenance

(1) All power and other specialized equipment should be protected and kept covered when not in use. Equipment that is not used regularly, or which use different insecticides, must be washed and flushed thoroughly with detergent and water after every use. Damaged parts should be repaired, or replaced promptly. Regular preventive maintenance should be exercised on all motors. This and other specialized work should be done by experienced professional personnel only.

(2) If a sprayer unit is powered by a gasoline engine, oil should be changed according to the manufacturer's instructions and kept up to the required level in the crank case. Belts should be fitted tightly over pulleys, and a protective covering should be installed to prevent injury in case the belts break loose.

(3) If using an electrically operated unit, check for breaks, loose connections, or other faults in the wiring and insulation. Always use the third wire for grounding to avoid injury from electric shocks.

e. Self-Propelled Aerosols

(1) Commonly known as "aerosol bombs". Insecticides are dispensed from high pressure gas filled dispensers that are available in either refillable or disposable containers. When a valve is opened (push button type in disposable containers and usually gate type shut off valves in refillable containers) the insecticide is dispersed into a fine aerosol due to the propellant action of Freon, a nontoxic gas, which is enclosed together with an oil solution of the concentrated insecticide.

(2) Aerosols marketed in disposable containers are widely used. The pest control industry and health agencies also use them to flush out insects from their breeding and hiding places, thereby locating suspected infestations, which later can be treated with residual applications.

Aerosol containers. Left, refillable; right, disposable

E. Fumigant Applicators

1. Fumigants are volatile (gaseous) chemicals. The toxic vapors emitted, enter the body by inhalation as well as by diffusing through the skin. Fumigants are classified among the most toxic pesticides used in pest and vector control operations. Fumigation also has the advantage of killing the ectoparasites (fleas, lice and mites) as well, which is a factor of considerable importance in controlling the spread of some diseases. Calcium cyanide (dust or granular form) and methyl bromide (liquid form) are the two fumigants that are widely used in outdoor fumigation to kill rodents (rats and gophers) within their burrows.

2. Calcium cyanide in the dust form is usually applied into the burrows with a foot pump, which was described earlier. The granular form of calcium cyanide may be introduced deep into the burrows with a long-handled spoon.

   When the calcium cyanide comes in contact with moist air or soil, it produces hydrocyanic acid gas, resulting in rapid kill.

3. Methyl bromide is a highly volatile and toxic fumigant. It is introduced deep into the burrows with a special injection pump. The methyl bromide liquid immediately produces gaseous fumes when it comes into contact with warm air.

4. Applicators (injection pumps) must be kept in good working condition and the seals should be regularly checked. If defective, worn seals must be replaced immediately to avoid any drippage or contact with the skin.

5. Following application of the fumigant, it is extremely important to carefully plug or seal all the burrows with soil to prevent any escaping gas. Methyl bromide should not be used where rodent burrows have exposed the tree roots, as this may severely damage or kill the trees.

   Fumigants are very toxic materials, hence only experienced and trained personnel should be permitted to make such applications to avoid serious accidents.

6. Respirators must be worn whenever applying toxic pesticides. Further information can be obtained by request, from the Department of Agriculture, for a list of approved respirators for protection against pesticides.

F. Safety Equipment and Miscellaneous Aids

Accomplishing a job in a safe manner, must be considered as the most crucial factor involved in pest and vector control operations. The items in the checklist provided below, may or may not be directly involved in completing the job, but will enable the personnel in perform-

ing an efficient service. Safety equipment may also come in handy not only to protect the operator, but also the public and property. Each truck or vehicle should be equipped with most of the items listed.

1. Safety Equipment

   a. Respirators and gas masks, with spare cartridges or cannisters.
   b. Fire extinguisher.
   c. First aid kit.
   d. Phone number of the local Poison Control Center, or the name, address, and phone number of the company doctor.
   e. Extra set of coveralls or uniform, or both.
   f. Gloves.
   g. 50-foot, 3-wire extension cord.
   h. Bump caps or hard hats.
   i. Grounding cables with clamps.
   j. Emergency flares.

2. Miscellaneous Aids

   a. Wiping cloth or rags.
   b. Paper towels.
   c. Soap and/or waterless hand cleaner.
   d. Clean or distilled water.
   e. Masking and/or plastic electrical tape.
   f. Disposable plastic bags.
   g. A good flashlight with extra batteries.
   h. Step ladder.
   i. Heavy rope.
   j. Overshoes ("booties")
   k. Aerosol bombs.
   l. One pair of crescent wrenches, hammer, screwdriver, pliers.
   m. Trash basket.

3. For Rodent Stoppage Jobs

   a. Hand or electric drill.
   b. Staple gun.
   c. $\frac{1}{4}$-inch mesh galvanized hardware cloth.
   d. Tin snips or wire cutters to cut hardware cloth.
   e. Large forceps or tongs for handling rodent carcasses.
   f. Plastic bags for disposal of carcasses.

A knowledgeable operator, along with a properly selected, clean, and well maintained piece of equipment, will project the mark of a true professional. The job should be accomplished with the least amount of effort, and fewer chances of accidents or on-the-job failures, or without having to borrow tools from his customers. All of these qualities combined, would surely enhance the operator's efforts in performing an efficient job, thereby promoting excellent public relations and gaining satisfied customers.

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